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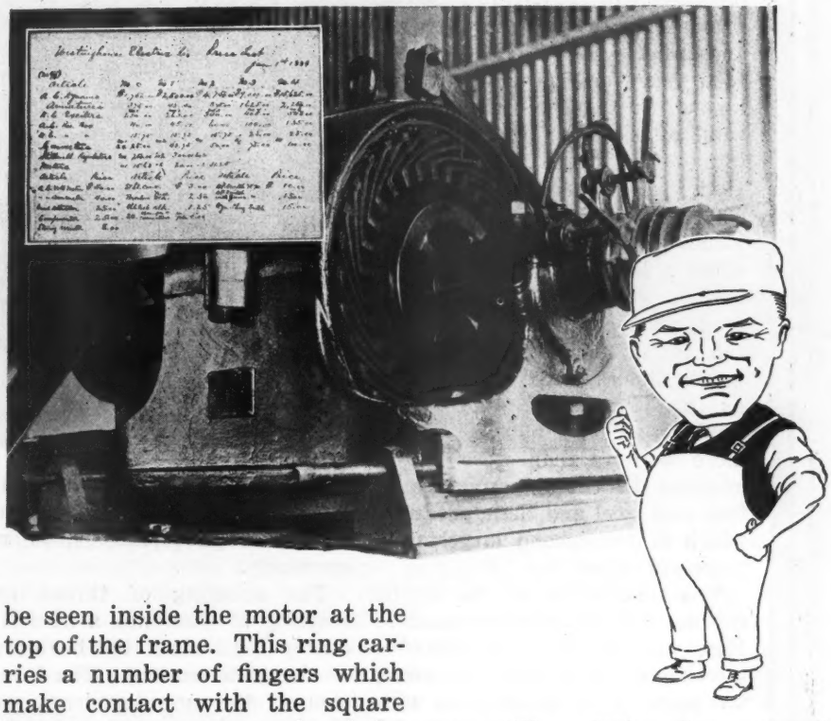
What Will a Motor Look Like 27 Years From Now?

Here's One That's Seen 27 Years of Service But Its Type Would Be Recognized Today By Only a Few Men



EVERY NOW and then evidence turns up which shows that some of the early electrical equipment was built better than the designers knew and from the standpoint of service rivals some newer designs. Here is a photograph taken in the Sacramento (Calif.) shops of the Southern Pacific Railroad of a Westinghouse Tesla type B alternating-current motor that has been in daily service for more than 27 years and is still going.

This is a 15-hp., 1,200 r.p.m., three-phase, 60-cycle motor operating at 500 volts that was installed in 1896, about two years after this design of motor was developed. It was built with a rotating primary and a stationary secondary provided with a series of U-shaped resistance grids bolted to the rear ends of the secondary bars for starting. When the rotating primary is up to speed the secondary is short circuited by moving the large lever at the top of the motor frame. This lever is connected to a large copper ring which can be seen inside the motor at the top of the frame. This ring carries a number of fingers which make contact with the square bosses at the upper ends of the cross connections. The operation of this motor was ingenious though complicated when compared with the induction design as we now know it.

With this picture we have inserted another on a somewhat different but related subject which shows that it was not a difficult matter at one time to know pretty much everything about the entire line of a motor manufacturer. This photo shows the complete price list and first catalog of the Westinghouse Electric and Mfg. Company dated January 1, 1889, a little over 35 years ago. It lists five alternators with the auxiliary equipment needed for lighting service. Only the 500, 750, 1,500 and 3,000 light machines were then available. The No. 4 unit was still a design "on paper." Today the supply apparatus catalog of this company contains something like 1,300 pages and it's no small job to keep up with the new things added every time it is reprinted.

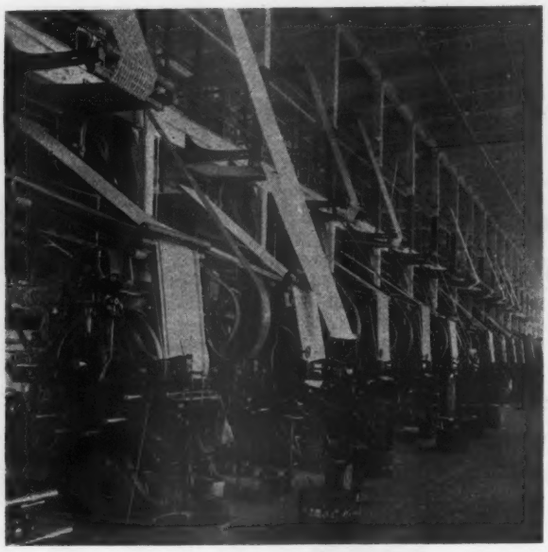
These two pictures typify the development that have attended electrification of industry during the lifetime of many of us who still call ourselves young. What will happen electrically during the next 35 years not even the wisest of us dare to predict. It is certain, however, that the electrical man then will be an extremely "wise individual" along certain lines.

Practical Pete

A Glimpse Into the

Four Plants of the Pacific Mills

Where cotton is put through the sixty-seven processes which are required to turn it into cloth. The fourteenth of a series devoted to the growth and extent of our basic American industries.



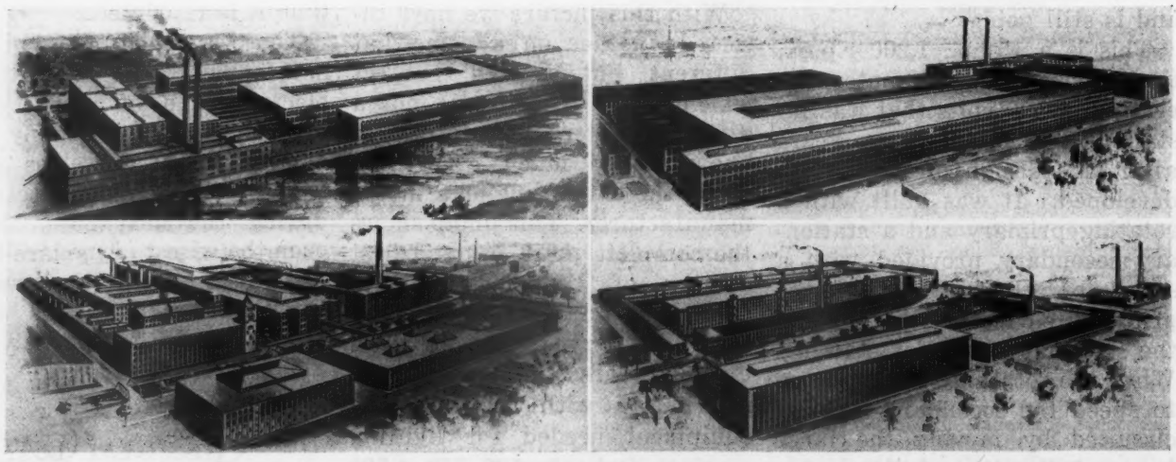
Machines for impressing the colors on printed cotton goods.
Each of this battery of forty-eight machines will print eight colors at once. The individual motor drive for each machine is located in a gallery above the machine. After it is printed the cloth goes up overhead, as shown and, after it is dry, is inspected and folded.

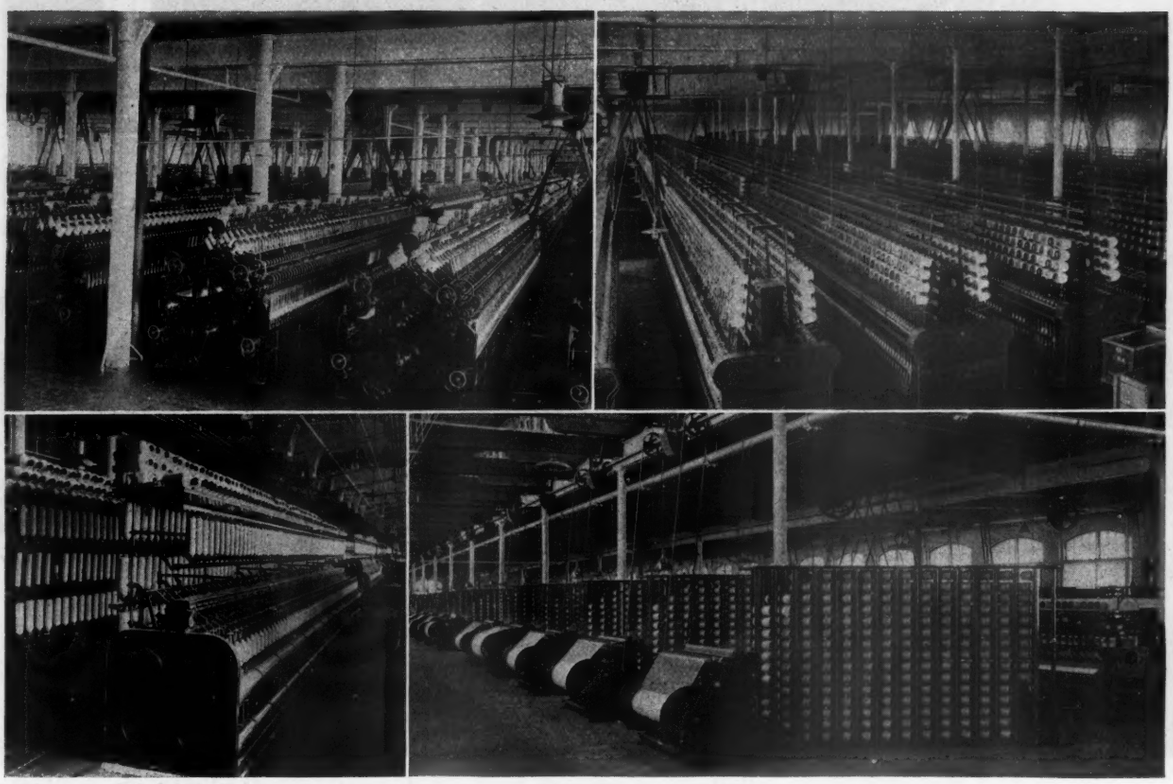
TEXTILES and textile products, according to the Manufacturing Census of 1921, is the second largest industry and ranks next to the food and food products industry. The total value of products, according to this report for 1921, was over $6,960,000,000. Although the value of the products is about a billion dollars less than of the food and food products industry, the textile industry requires almost three times as many workers, and employs about 500,000 more workers than were engaged in the manufacture of iron and steel and their products, which is the second largest employer of labor.

The total value of the textile fabrics and material produced in 1921 was almost $3,900,000,000; the largest single item, of course, was made up of cotton goods with a value of about $1,280,000,000. This was about 50 per cent more than the value of the worsted and woolen goods manufactured. Of the manufactured textile products mens' and womens' clothing is by far the largest item, with a value of about $934,000,000 and a little over $1,022,000,000 respectively.

The spinning of thread and weaving of cloth was a home industry until about the beginning of the 19th century. The invention of the spinning jenny and the power loom gave an impetus to weaving, which made it one of the first factories where a large number of workers were employed. The invention of the cotton gin in the United States about 1793, enabled the cotton seed to be removed economically from the boll, so that cotton fiber could be produced in sufficient quantities to permit its use for the manufacture of thread and cloth. The manufacture of cloth has developed large industrial institutions. The manufacture of the cloth

These four Pacific mills are located at Lawrence, Mass.
The Bleachery of the Print Works department contains the largest bleach house in the world with eighty bleaching kiers, each of which holds about 50,000 yards of cloth. The plant has a total boiling capacity of about 370 tons of dry cloth each day. The Print Works, upper right, contains fifty printing machines and a dye-house for printing, dyeing and finishing cotton fabrics. The Worsted department, lower left, operates 92,464 worsted spindles, 31,360 spindles for combed cotton yarns and 3,753 looms for making cotton-warp and womens' all-wool dress goods. The Cotton department, lower right, operates 184,096 spindles and 3,811 looms for making cotton cloths for dyeing, printing and bleaching. In addition to these, the company has several mills at other locations.





Views of four different departments in a Pacific mill.

The Worsted Spinning room (upper left) shows part of the 260 cap-spinning frames operated in the Worsted department. The Cotton Twisting department (upper right) shows the equipment used for making two-ply yarns. In the Cotton Roving department (lower left) the thread is wrapped on bobbins. Preliminary to weaving, the threads are wrapped on a warper (lower right) where, if a thread should break, the machine is automatically stopped.

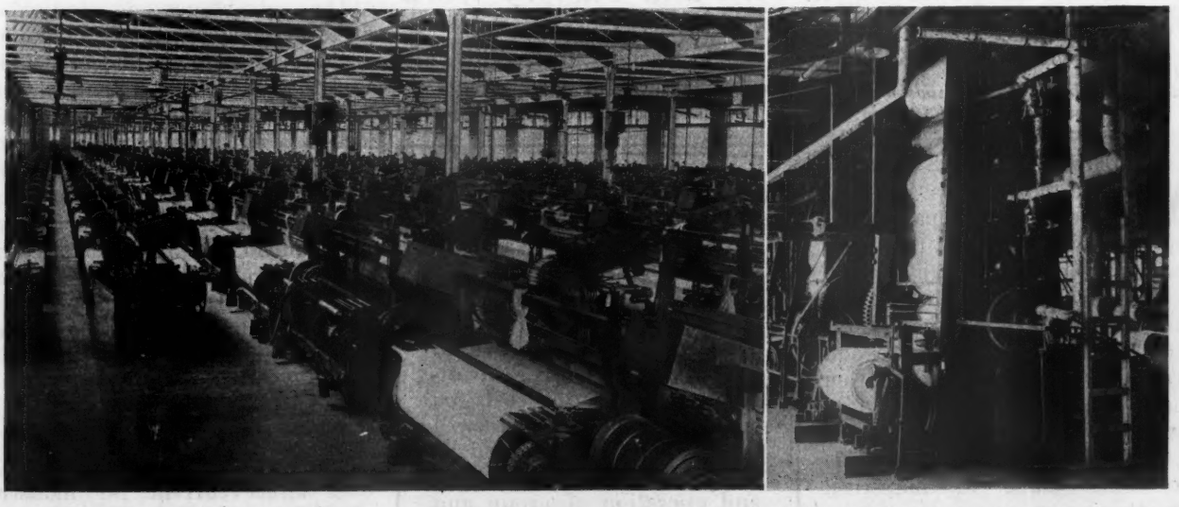
into clothing and other products, however, is, in many cases, carried on in small industrial plants. The reason for this is easily seen from the fact that the manufacture of cotton cloth, such as twill, requires sixty-seven distinct operations, from the ginned cotton to the bolt of cloth. This necessitates large investments in machinery and in raw material. The manufacture of many finished textile products, such as cotton aprons or dresses, requires a comparatively small investment.

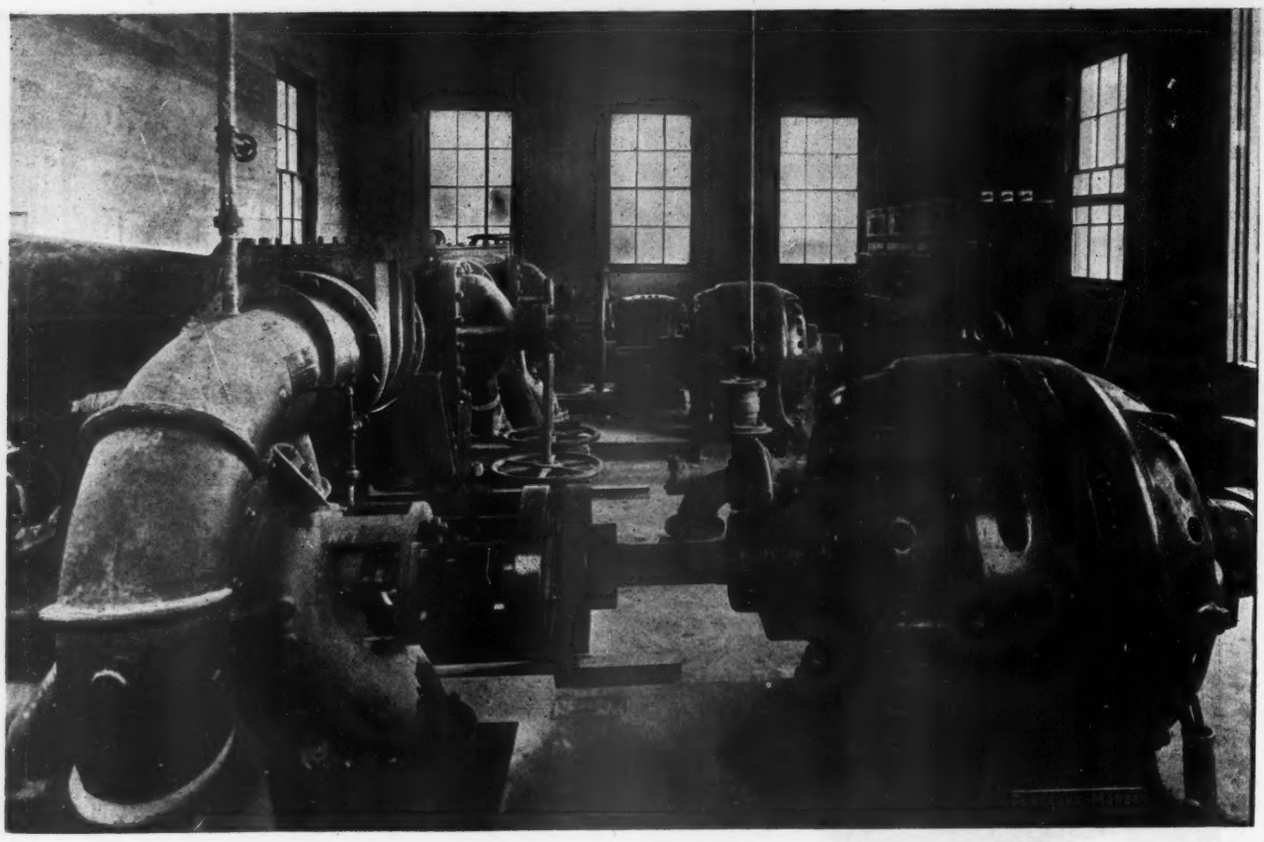
In the early days of the textile industry, most of the plants were located in the New England states. Because of the proximity to the cotton fields, many mills are now located in the Carolinas and other Southern states.

One of the largest manufacturers *(Continued on page 108)*

Weaving and finishing cloth

In the weaving room of the Worsted department (lower left) are shown some of the 3,670 looms operated. The view at the lower left shows the line of calendars in the bleached white Finishing department of the Print Works.





Any machine which takes considerable power and operates at a fairly constant load not much below its maximum load should be considered for individual drive.

Such a machine should be so driven if it requires 25 hp. to 50 hp. or over. Many smaller loads can be individually driven if special conditions such as exceptionally high speed will show a saving.

Service Conditions That Indicate

When to Use Group and Individual Drives

Together With Practical Operating Requirements And Supporting Data That Have Been Developed From Long Experience in Mill and Factory Work

By ROBERT W. DRAKE

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A CAREFUL ANALYSIS of the reputed advantages of individual drive as compared with group drive will show that the latter has a much wider field of application than is commonly supposed. The following article analyzes the advantages of each method of drive and shows the proper field of application for each.

Twenty-five years ago, when the first applications of electric drive were being made in industrial plants, there were many cases where the logical substitute for the old engine drive was an individual drive for each machine tool. This was due to the lack of development of motors and machine tools existing at the time. In many instances, decisions were based on a careful analysis of conditions, but many other installations were made without adequate, detailed knowledge of the situation.

THIS IS the first of three articles that will analyze the advantages of group and individual drives. The article to follow will go into detail concerning the advantages of group drive and will give an actual comparison of investment and operating costs for each. The third article will discuss points that should be considered in the installation and operation of group and individual drives.

The advantages of individual drive were evident to all but the disadvantages were much less evident. Within a few years individual drive became a fad. Many engineers who lacked actual operating experience with it, believed that a little further development in motors and control would make individual drive well nigh universal. However, as time went on and more engineers gained experience with both kinds of drive, individual drive came to be less and less generally regarded as a universal panacea.

During the past ten years alternating current has been developed so that it offers many advantages over direct current for industrial plant drives. Since alternating current lends itself to individual drive less easily than direct current, this

fact has greatly influenced the decision as to the type of drive to be used.

At present the most experienced engineers engaged in industrial power applications recognize that both individual and group drives have their places. Fifteen years' experience has convinced the writer that the field of group drive is much broader than was originally surmised. The present tendency of alternating current to displace direct current has caused machine tool builders to design machines which have a performance in group drive which closely approaches, from a production standpoint, the possibilities of individual drive.

The discussion and comparison which follows is intended to give an unbiased survey of the "present state of the art," and will offer interesting suggestions from the standpoint of design, operation and economics.

In the light of the general principles outlined in the accompanying boxed statements of reputed advantages, let us consider those applications where individual drive shows undoubted superiority before proceeding to discuss each point in detail.

Applications Where Individual Drive Shows Superiority

In heavy machine shops, locomotive shops, and the like, where the parts to be handled are heavy and crane service is desirable over a great part of the floor area, individual drive is almost necessary over that part of the floor reached by the traveling cranes. The elimination of overhead shafting and belting which interferes with the crane hook or low-hanging loads, leads to almost certain decision for individual drive in such instances.

In some cases a basement with group lineshafting on the basement ceiling offers a fair substitute, but in general, shop buildings where heavy work is done, are best built without basements on account of the heavy floor loads which must be provided for. A considerable number of heavy machines will require foundations built through the basement anyway. The fact that an indefinite number of belt openings cannot be cut through a heavy concrete floor without unduly weakening it, limits the moving of machines which normally goes on in a shop from time to time as the product or processes are changed.

At present the most frequent layout for such a shop consists of a central aisle served by overhead traveling cranes and used for machine work or erecting, or both. Such machines as are located in the central aisle are individually driven. At each side are one or more balconies. On the ground floor under the balconies and on the balconies are lighter machines doing work for which crane service is unnecessary. The majority of these machines are ordinarily group driven.

On very heavy work, such as large engine bedplates, slow speed alternator field frames, and the like, it is often more convenient to move the machine tools to the work than it is to move the work. It is self-evident that such portable machines are best individually driven.

Any machine which takes considerable power and operates at a fairly constant load not much below its maximum load should be considered for individual drive. Such a machine should almost certainly be individually driven if it requires 25 hp. to 50 hp. or over, and many similar loads requiring less horsepower can be individually driven with economy if some special condition such as exceptionally high speed will add to the consequent saving. Under the above classifications will come most large wood-planers, and most motor-driven air-compressors. Such machines can ordinarily be as-

I. Principal Reputed Advantages of Individual Drive.

A. Elimination of overhead shafting and belting.
   1. Lineshaft friction losses eliminated.
   2. Maintenance of shafting and belting eliminated.
   3. Cleaner shop.
   4. Better light.
   5. Closer speed adjustment of the tool to the work.

B. Location of machines to suit the continuity of a manufacturing process without regard to the location of lineshafting.

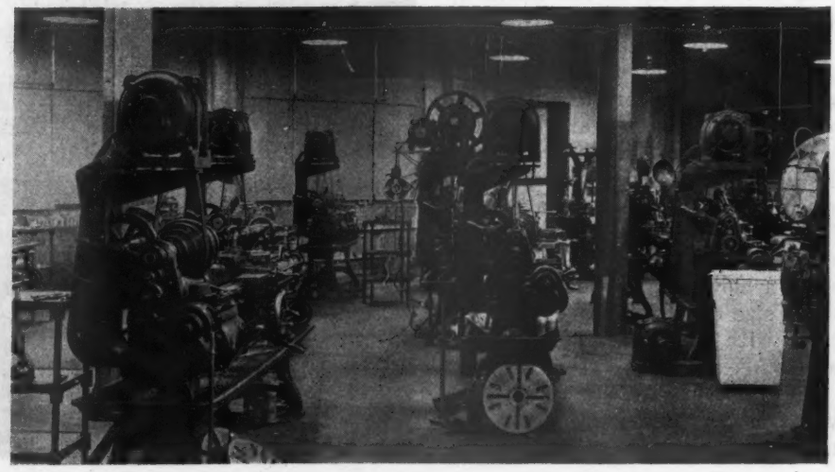
C. When only a small proportion of the installed machines is to be operated (e. g., overtime or slack season) it is not necessary to operate idle shafting and belting.

D. On large work the tool may be taken to the work instead of the work to the tool.

II. Principal Reputed Advantages of Group Drive.

A. General advantages.
   1. Lower first cost.
   2. Lower electrical maintenance expense.
   3. Breakdowns with consequent delay to production less frequent.
   4. Possible to standardize more fully on motor styles and speeds, with consequent possibility of carrying complete line of spares and resulting in greatly decreased delay from such breakdowns as do occur.

B. Particular advantages when using a.c. power.
   1. Here the lower first cost extends back through the distribution system and to the power house.
   2. If the power is purchased, this is reflected in a lower unit cost for power because of the greatly increased power factor attainable with group drive.



This picture shows some of the advantages of individual drive.

These are elimination of overhead shafting and belting, cleaner shop and better light. Since the motors operate at constant speed and all speed changes are made by pulley or gear changes, as far as production is concerned, the machines could be group driven with a consequent saving in first cost and electrical maintenance. Although the individual drive is used some of the disadvantages of belt drive are present because of the short belt between motor and lathe pulley.

Table I—Results of Tests That Indicate the Extent of Shaft and Belt Losses for Group Drives

Type of Work	No. of Counter- and Jack-shafts	Lineshaft			Hp. of Motor	Total Load		*Losses in Lineshaft Countershaft and Belts with Light Load in Hp.	Per Cent of Average Load
		Speed in RPM	Length in Feet	Size in Inches		Ave. Load (Hp.)	Max. One Hour (Hp.)		
Foundry mills	6	200	99	2.75	50	40	53	4.00	10
Foundry mills	6	200	99	2.75	50	25	42.5	3.00	12
Wood working	5	300	40	2.75	50	45	80	7.35	16
Cordage and twine	2	.....	18	3.375	40	35	.....	3.80	11
Heavy grinding	3	200	240	2.75	100	80	110	7.20	9
Canvas making	11	225	75	2.00	5	3	8	0.212	7
Canvas making	11	225	59	2.00	7.5	5	.....	0.562	11
Press work	7	200	45	2.375	7.5	7	17	3.32	47
Wood pattern shop	11	200	50	2.375	15	11.5	.....	1.55	10
Forge shop	14	200	267	2.375	100	100	130	12.50	13

*The hanger bearings are not of the ball or roller type, but are self-oiled, babbitt-lined sleeves fitted with wicks and oil cellars. Practically none of the countershafts has ball or roller bearings. The majority are of the ordinary tight and loose-pulley variety. Special countershafts where necessary were generally purchased with the driven machines, and are of various types. The shafting is of ample size for the work.

sured a steady load approaching capacity by shutting down units.

Belts cannot be operated at any desired speed. Beyond approximately 6,000 ft. per minute the tendency of the belt to leave the pulley, due to centrifugal force, greatly reduces the power which it transmits per unit of width. If the power to be transmitted is considerable, any attempt to offset this by reducing pulley diameters leads to undesirable or impossible drives due to the increased belt width required. To a certain extent silent chains extend the speed range, but they are by no means universally applicable.

Some machines when most economically designed run at so high a speed that operation from a group lineshaft is inconvenient or impossible. If they offer a fairly steady load approaching their maximum load they can be individually driven to advantage. If they do not offer such a steady load, but their horsepower requirements are considerable, there is often no reasonable alternative but individual drive.

Such drives include centrifugal pumps, especially those requiring more than 15 hp. or so, centrifugal compressors, centrifugal gas boosters and the like, which are usually designed for the highest practicable speed. In this class are also most fans, blowers, and exhausters of considerable size, although in some cases a blower or exhauster of moderate size can be grouped to advantage with the machine which it serves.

A discussion of the reputed advantages of individual drive will now be undertaken.

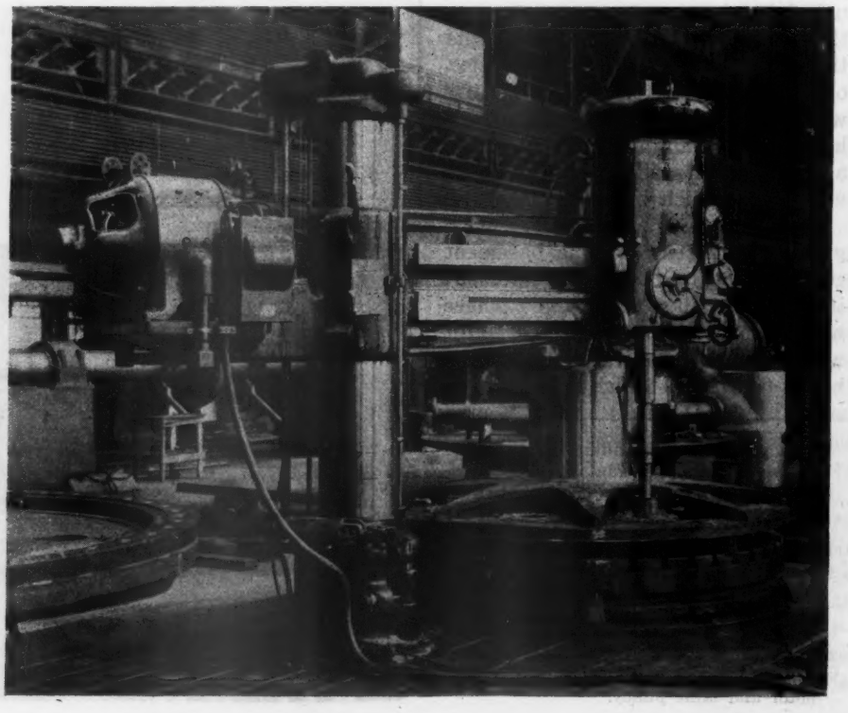
A. Elimination of Overhead Shafting and Belting.—When it is desired to eliminate overhead shafting and belting, individual drive is the best solution.

1. Elimination of Lineshaft Friction Losses.—These losses have been stressed by many authors as one of the outstanding advantages of individual drive. The saving of power from this source is more fancied than real because various factors combine to reduce the average motor efficiency of individual drives to an extent which frequently more than offsets the shafting and belt losses in the equivalent group drive.

To give an idea of the ordinary magnitude of shaft and belt losses, I have tabulated results (shown in Table I) of a number of tests on representative group drives. This shafting is not "modern" by any means. The hanger bearings are not of the ball or roller type, but are babbitt-lined sleeves fitted with wick self-oilers and oil cellars. Of the countershafts practically none has ball or roller bearings. The major-

In certain industries, elimination of dust and dirt is an essential part of operating conditions.

Individual drive makes possible a cleaner shop than does group drive. In such industries as the food or textile, gains in this respect are worth considering and may even be a controlling element of choice.



ity are of the ordinary tight- and loose-pulley variety. Special countershafts where necessary were generally purchased with the driven machines, and are of various types. The shafting is of very ample size for the work. In general, I believe that this practice reduces friction, where shafting is carefully aligned, through the reduction of deflection from belt stresses.

Weighted for capacity of drive, the average losses in line-shafts, countershafts, and belts in group drives in this shop appears to be approximately 12½ per cent. The actual loss is probably nearer 16 per cent, for belt losses increase with load. For comparison with this we must approximate the difference in average motor efficiency between individual drive and group drive.

The average motor efficiency of an individually-driven group of machines is considerably lower than that of the same machines group driven because the average motor is much smaller, and smaller motors are less efficient.

It is well known that the total horsepower of motors necessary for individual drive is far greater than that required for an equivalent group drive. An individually-driven machine must be driven by a motor capable of doing the heaviest job which will ever be done on the machine. The machine is seldom operated at this maximum, and the machines in the group are never called upon for maximum output simultaneously. A group drive requires a motor large enough to carry the heaviest average continuous load on the group. For example, in wood working, an individually driven matcher must be motored for very heavy reduction with dull knives on poorly seasoned hardwood, for such a job will sometimes occur. But it is most unlikely that in a group of wood-working machines, many will ever be working simultaneously at such jobs. In fact with many group drives it can be safely assumed that some machines will be down for setting up a new job, sharpening tools, inserting stock, checking dimensions and the like. The short-time overload capacity of the motor will bridge over periods when this is not true.

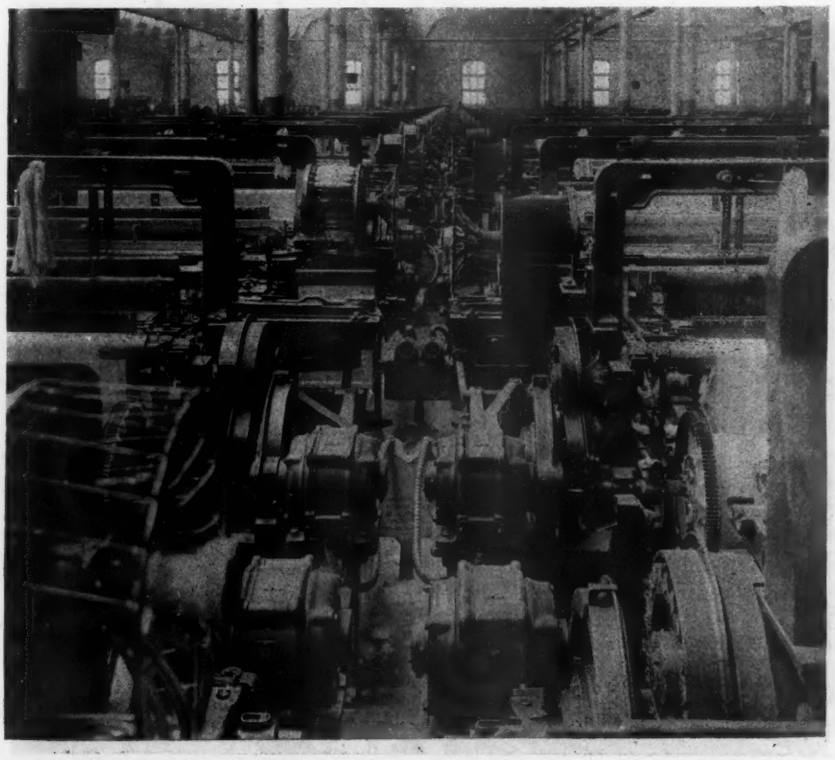
The ratio of installed motor capacity for individual drive to that for group drive of the same machines, varies for different sorts of driven machines from five to two. Five is common where the manufacturers' recommendations as to motor sizes are accepted without study and two is exceedingly uncommon. For example, in several cases detailed information as to the work to be done was furnished to the principal American manufacturer of heavy machinery in his line. The work is such that a large part of the time is required for getting work in and out of the machine which he recognized, as evidenced by his estimates of daily production. The machines are built with a heavy flywheel to bridge the instantaneous peaks of power demand, but the manufacturer's recommendations as to motor rating for the job proved on subsequent tests to equal the maximum instantaneous load on the motor lasting less than 3 per cent of the time. Four of these machines have been running for several years, individually driven by motors of 20 per cent of the recommended capacity without any repairs. The motors run cool and could well be smaller still.

Probably as good an average as any, for existing installations in the metal machinery industries, is that given in "Machinery's Encyclopedia," Vol. 4, page 441, as follows: "Actual experience has shown that for group driving an ordinary machine shop, a motor of one-fourth to one-fifth the total horsepower of the motors required for the individual machines is sufficient."

The writer's experience is, that for many routine manufacturing applications, not jobbing nor manufacturing which approaches jobbing in its variety, this can by very careful engineering be made one-third.

Thus we may assume for comparison, on the average, motors in individually-driven groups where the engineering has been exceptionally good, will average 30 per cent full load. In a group-drive plant where equivalent engineering skill has been applied to the choice of motor sizes, group-drive motors will usually be of normal or 40 deg. rating. They will be so chosen that at periods of maximum load on the group, they are overloaded 25 per cent or more, according to the capabilities of the individual styles and sizes, and the time of year when the maximum load is likely to occur. The average all-year load on such a group-drive motor in a plant having some variation in business may be assumed to be between 75 per cent and 100 per cent full load, say 87 per cent. This amounts to 70 per cent of the maximum load during the busy season.

Motors for individual drives must in general be slower in speed than motors of corresponding capacity used in group drives. Slow-speed



Portable machine tools, such as the one shown, must of necessity be individually driven.

On heavy work, such as large bedplates, alternator field frames and the like, it is often more convenient to move the machine tools to the work than it is to move the work.

Table II—Typical Performance of Sixty-Cycle Alternating-Current Motors

Motor Rating in Hp.	Speed in RPM.	Operating Characteristics of Motors			
		87% of Load		30% of Load	
		Power Factor in Per Cent	Efficiency in Per Cent	Power Factor in Per Cent	Efficiency in Per Cent
1	600	52.5	72	24	52.5
	1800	71	84	29	72
5	600	68	83	35	70
	1800	86	86	57	79
25	600	80	89	67	83
	1800	89	90.5	47	83
100	514	82	91	54	83
	720	87	91	60	84

The extremes of speeds shown in the above comparative tabulation are chosen to emphasize the comparison. It is realized that average speeds of group drive and individual drive motors are ordinarily somewhat less unlike.

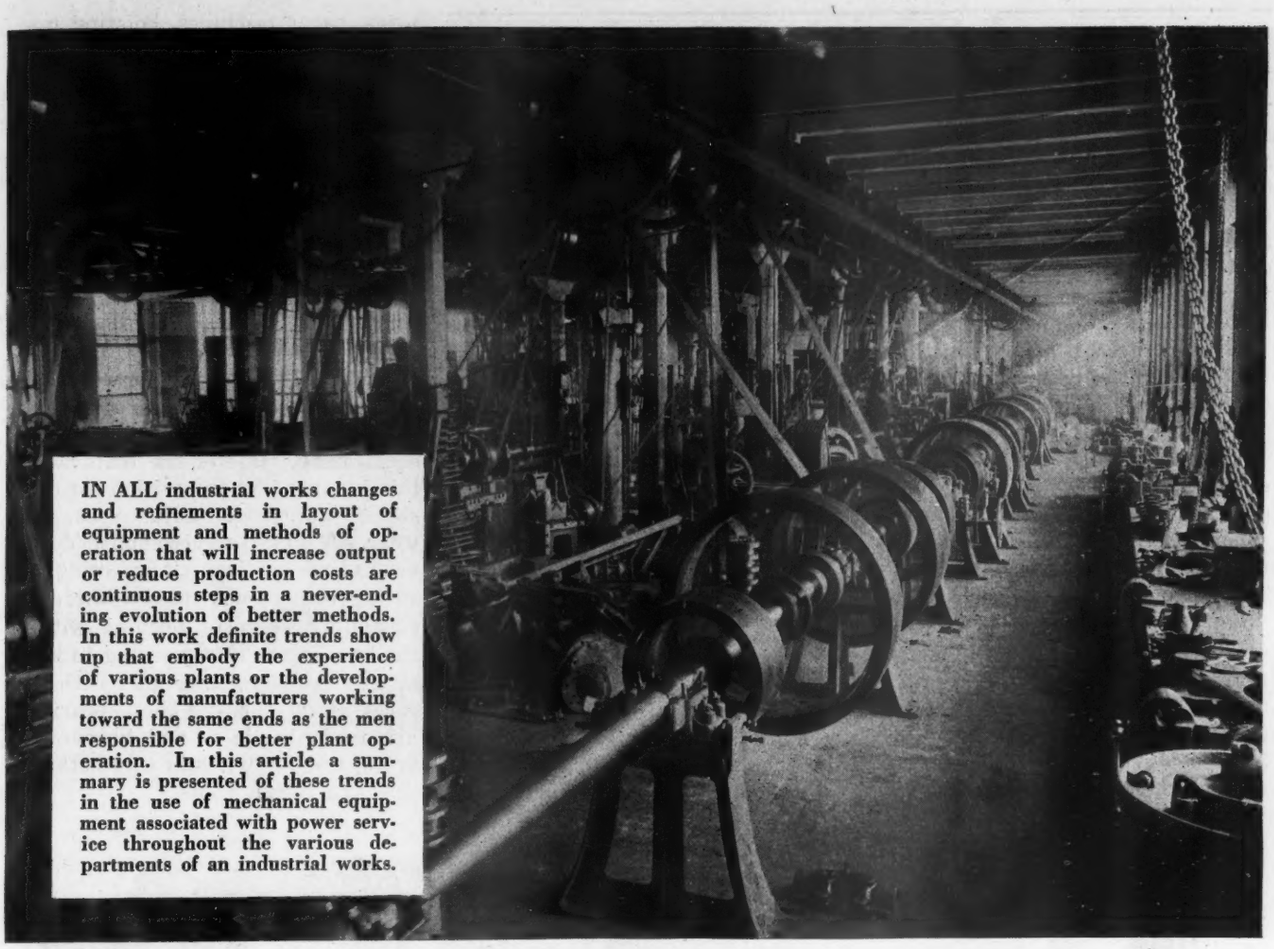
motors lend themselves better to efficient and reliable gear drives, and even when a motor is connected to an individually-driven machine by a belt, the belt is likely to be vertical, the centers short, and the maximum possible size of driven pulley limited, so that conditions are unfavorable for a high-speed motor. The efficiency of slow-speed motors is generally less than that of high-speed motors of the same capacity.

In Table II is given a condensed outline of performance which is characteristic of modern 60-cycle alternating-current motors. The relative speeds in the table are in more extreme contrast than in average practice. In practice 60-cycle alternating-current, constant-speed motors used on group drives have an average efficiency (weighted for size of motor) of approximately 86 per cent and the average efficiency of similar motors as used in individual drive is 75 per cent. Actually this latter figure is high for most large plants due to the fact that the average motor in a large plant where good engineering has been used in the electrical design, operates above rated voltage. The starting torque of squirrel-cage, induction motors (which are very generally used in such plants) as ordinarily designed, is as low as is practicable. In fact during the last ten years in an effort to obtain higher efficiency, the tendency has been to reduce the starting torque so much that the motors are unsuitable for many drives; hence motors with special high-resistance rotors are necessary. If one wishes to "stick to standard" motors to keep down the necessary stock of spares, it is necessary, on some drives, to reverse the connections of the starting compensator, so that the motor starts on a voltage higher than full line voltage. The starting torque of an induction motor varies as the square of the voltage; therefore the voltage must be at least maintained at rating on all motors, and as a consequence, in a large plant the motors near the power houses or substations are operated at say 10 per cent over-voltage. The average motor may therefore be said to operate at 5 per cent over-voltage. This 5 per cent over-voltage has a negligible effect on the efficiency of the group-drive motors operating near full load, for the effect on the two principal losses, the losses in the copper and iron, approximately offset each other, but for the individual-drive motor operating on the average at only 30 per cent load, the efficiency is lowered about 1 per cent for our hypothetical average motor.

Hence we see that for constant-speed, alternating-current motors the loss in motor efficiency of individual over group drive is in the order of 12 per cent and just about offsets the additional lineshaft, belt and countershaft losses of group drive. The efficiencies of direct-current motors at fractional loads are decidedly lower than the efficiencies of corresponding alternating-current motors. Thus, constant-speed direct-current *(Continued on page 106)*

A hammer drive such as the one shown does not readily lend itself to group drive.

This is because the motor is required to slow down when the load peak occurs and thus permit the flywheel to supply the peak load. The result is a more even power demand and permits using a smaller motor than would otherwise be required. The intermittent operation of the individual units is another argument for individual drive.



IN ALL industrial works changes and refinements in layout of equipment and methods of operation that will increase output or reduce production costs are continuous steps in a never-ending evolution of better methods. In this work definite trends show up that embody the experience of various plants or the developments of manufacturers working toward the same ends as the men responsible for better plant operation. In this article a summary is presented of these trends in the use of mechanical equipment associated with power service throughout the various departments of an industrial works.

Trends and Practice In the Use of

Mechanical Devices in the Path of Power Service

Throughout Industrial Works Together With Details of Recent Developments by Those Companies Which Are Making This Class of Equipment

By G. A. VAN BRUNT

Managing Editor, Industrial Engineer

IN THE INSTALLATION and application of power service equipment, distinct trends and tendencies which are of interest to those who are responsible for the operation and maintenance of such equipment have been manifested during recent years. These trends, in many cases, have created new devices or improvements on existing equipment, designed to give increased operating efficiency, greater reliability of operation and a reduction in maintenance costs. Some of these tendencies, together with developments typical of improved practice in the use of power service equipment will be discussed in this article.

Starting with the motor, as the source of power, present practice tends to the use of higher motor speeds than were formerly used. This is largely due to the fact that a high-speed motor is, in general, smaller and cheaper in first cost than a low-speed motor of the same horsepower rating. Also the introduction of higher working speeds in production machines themselves has gradually resulted in a general increase in driving speeds, with consequent increase of production per unit.

Along with increased motor and machine speeds have come higher line and countershaft speeds. Whereas the practice formerly was to keep lineshaft speeds down to somewhere around 100 to 150 r.p.m., which naturally involved the use of large pulleys on the lineshaft, the tendency now is to run the lineshaft from 225 r.p.m. to 300 r.p.m. and use smaller pulleys. In this way the necessity of getting a large reduction in speed between motor and lineshaft and then securing a large increase in speed between the lineshaft and the production unit is avoided.

Higher line- and countershaft speed means, however, increased friction and wear of bearings. To offset these disadvantages increasing use is being made of antifriction, ball or roller, bearings. The increased application of these types of bearings is not, of course, confined to lineshafts, but embraces a wide variety of equipment.

Bearings and Bearing Metals

As examples of the new designs of antifriction bearings which have been brought out recently, mention may be made of the spherical type roller bearing developed by SKF Industries, Inc., and a disk-roller bearing put out by the Whitney Disk-Roller Bearing Company.

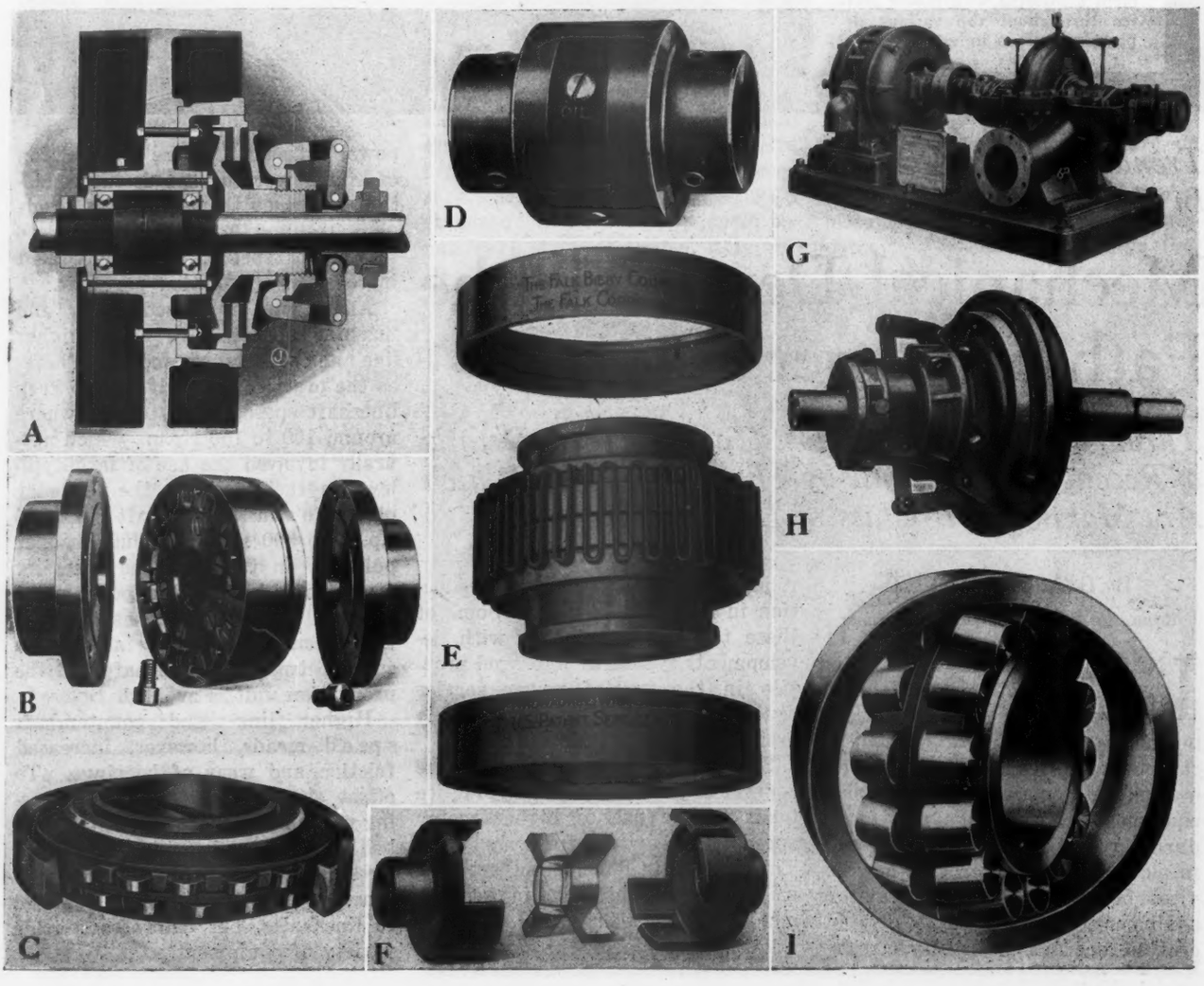
The new SKF bearing, which follows closely the design of the self-aligning ball bearings made by this company, contains two rows of rollers, each of which has convex sides so that its periphery is curved in two planes. The outer race is ground spherical over its inner surface so that it can be slipped over the rollers. The inner race has two concave surfaces in which the rollers fit and make contact for their full length. Between these surfaces is a guiding flange. The shapes of the parts and the action of the forces cause the inner ends of the rollers to bear against the flange, which maintains them with their axes parallel to that of the shaft. The bearing is self-contained and self-aligning and has, it is claimed, the ability to carry a thrust load of considerable magnitude.

The application of this bearing to railway motors, railway journal boxes, paper machines, hoisting machinery, rolling mills, rolls and flywheels, flour mills, flaking mills, steel mill motors, electric railway motor-generators, log frame saws, rotary furnaces, tube mills, and a number of miscellaneous applications, has proved that it is well adapted to the requirements of heavy-duty service.

The Whitney disk-roller bearing is a two-point contact bearing and consists of a cage containing disk-shaped rollers which are laterally guided and supported between adjustable bearing members, a cup and a cone which have conical faces of equal angle. One of the features of this bearing is the provision for constant, automatic adjustment for wear. This is accomplished by means of an especially designed spring which constitutes a laterally-expanding sleeve or bushing within the bore of the cone, serving to keep all of the rollers in contact with the races at all times. These bearings are made in light- and heavy-duty types, and for withstanding both radial and thrust loads.

New developments in mechanical equipment of interest to industrial engineers.

(A) Lemley friction-clutch, ball-bearing pulley manufactured by W. A. Jones Foundry and Machine Co., Chicago, Ill. (B) Francke high-speed-type flexible coupling, Smith & Serrell, Newark, N. J. (C) Whitney disk-roller bearing made by Whitney Disk-Roller Bearing Co., Chicago, Ill. (D) Higgins flexible coupling made by the Tomkins-Johnson Co., Jackson, Mich. (E) Falk-Bibby flexible coupling manufactured by The Falk Corporation, Milwaukee, Wis. (F) Francke fractional-horsepower flexible coupling developed by Smith and Serrell, Newark, N. J. (G) Underwriters' single-stage fire pump, made by Allis Chalmers Manufacturing Co., Milwaukee, Wis. (H) Lemley friction clutch manufactured by W. A. Jones Foundry and Machine Co., Chicago, Ill. (I) Skayef roller bearing made by SKF Industries, Inc., New York, N. Y.



The various types of ball and roller bearings, with details of their installation on lineshafts and in motors, were described in the September, 1922, issue of INDUSTRIAL ENGINEER. Further information on the use of ball and roller bearings in motors will be found in the report of the special bearing committee of the Association of Iron and Steel Electrical Engineers given at the Buffalo convention of the association, which was reported in the October, 1923, issue of INDUSTRIAL ENGINEER.

The following companies have been prominently identified with the development of ball, roller and similar type bearings:

American Roller Bearing Co., Pittsburgh, Pa.; Auburn Ball Bearing Co., Rochester, N. Y.; Bower Roller Bearing Co., Detroit, Mich.; Chicago Pulley and Shafting Co., Chicago, Ill.; Fafnir Bearing Co., New Britain, Conn.; Hyatt Roller Bearing Co., Harrison, N. J.; Nice Ball Bearing Co., Philadelphia, Pa.; Norma Company of America, Long Island City, N. Y.; Schatz Manufacturing Co., Poughkeepsie, N. Y.; SKF Industries, Inc., New York, N. Y.; The Ball and Roller Bearing Co., Danbury, Conn.; The New Departure Manufacturing Co., Bristol, Conn.; United States Ball Bearing Manufacturing Co., Chicago, Ill.

A roller-bearing countershaft box has been developed by the St. Louis (Mo.) Machine Tool Co. for use with its products. The box is fitted with an adjustable taper roller bearing, and has suitable sockets so that it will fit in standard hangers. The back of the box is solid, while the front has the usual style of end plate.

Considerable attention has also been paid to the development and production of better bearing metals for plain bearings. Among the new bearing metals may be mentioned Stewart Brons, made by the Stewart Manufacturing Corporation, Chicago, Ill. This is a copper-lead alloy the components of which will not, it is claimed, segregate on repeated melting and cooling. On failure of lubrication it is said that this metal sweats a small amount of lead when it reaches a temperature of 600 deg. F., and thus becomes self-lubricating. The melting point of the metal is 1,700 deg. F.

The American Metal Products Co., Milwaukee, Wis., has also recently produced what is known as Ampco bronze. This bronze is made in several grades of hardness and is intended for use in the manufacture of bearings, gears, worms, and so on.

Agrilite bearing metal, manufactured by the American Injector Co., Detroit, Mich., is another recent development. This is a bronze consisting of copper, tin and lead, with the lead content high enough to produce the self-lubricating property.

Belting and Pulleys

In line with the general increase in lineshaft and pulley speeds, belt speeds have likewise been increased somewhat. There is, also, a growing tendency on the part of belt users to devote more attention to reclaiming and rebuilding old belting. In this way the useful life of a belt can be considerably extended. Several firms are specializing in this work.

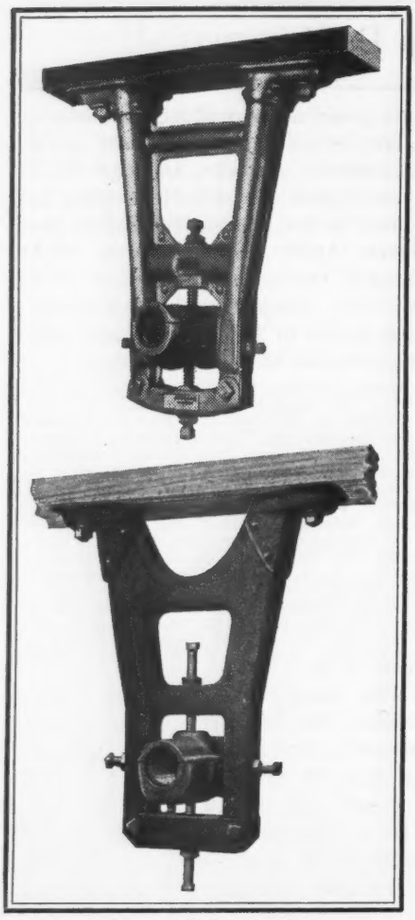
During the past five years or so a large amount of testing and research work on leather belting has been carried on by the Government and by the leather belting manufacturers, and much very valuable information has been obtained. Application of this information during the past year to the process of manufacture has brought about scientific control and a number of improvements in tanning and in some of the other operations involved. This has resulted in the production of belting which, it is claimed, is at least 25 per cent better than that which it has been possible to produce heretofore.

The selection, application and maintenance of belts, together with a description of the various types in industrial use, were discussed in the March, April, May and June, 1923, issues of INDUSTRIAL ENGINEER. The following companies have contributed much to the development and improvement of leather belting:

Acorn Leather & Belting Co., Detroit, Mich.; The Leather Belting Exchange, 119 S. Fourth St., Philadelphia, Pa.; The Chesapeake Belting Co., Baltimore, Md.; Chicago Belting Co., Chicago, Ill.; Detroit Oak Belting Co., Detroit, Mich.; The Graton & Knight Mfg. Co., Worcester, Mass.; Hide Leather & Belting Co., Indianapolis, Ind.; Jewell Belting Co., Hartford, Conn.; Laurence Belting Co., New York, N. Y.; Leather Kraft Co., Cleveland, Ohio; The Monarch Belting Co., Cleveland, Ohio; F. Raniville Co., Grand Rapids, Mich.; J. E. Rhoads & Sons, Wilmington, Del.; W. H. Salisbury & Co., Chicago, Ill.; Chas. A. Schieren Co., New York, N. Y.; The Taylor Belting Co., Indianapolis, Ind.; I. B. Williams & Sons, Dover, N. H.

The American Pulley Co., Philadelphia, Pa., has brought out a new design of steel split pulley. This pulley has six arms which are braced and set edge on. The rim is made like a channel iron, with central flanges and safety beaded rims; the arms are riveted to these central

A clutch saves power on this elevator drive by cutting out idle shafts and pulleys.



Above, this steel hanger is manufactured by the American Pulley Co., Philadelphia, Pa. Below, new design of steel hanger made by Dodge Manufacturing Corporation, Mishawaka, Ind.

flanges. The all-steel parting hub is clamped to the shaft with bolts.

A roller-bearing loose pulley, manufactured by the St. Louis Machine Tool Co., St. Louis, Mo., has recently been placed on the market. This pulley is equipped with a pair of adjustable, taper roller bearings and is made in any size from 2½ in. to 22 in. in diameter. In the small sizes the bearings are mounted directly on the shaft; in the larger sizes the bearings are mounted in a sleeve.

A pulley covering for reducing belt slippage has been brought out by the Monarch Belting Co., Cleveland, Ohio. This covering consists of treated duck which is cemented to the face of the pulley with a special cement. The covering is laid on in a single thickness, with a closely-fitting butt joint at the junction of the ends. It is claimed that it is unnecessary to use non-slip preparations on belts which run over pulleys faced with this fabric covering.

A description of the different types of pulleys, together with directions for ordering and installing them, was given in the November and December, 1922, issues of INDUSTRIAL ENGINEER.

Improvements in the design and manufacture of pulleys have been largely due to the work of these companies:

American Pulley Co., Philadelphia, Pa.; Birkle Machine Co., Chicago, Ill.; W. E. Caldwell Co., Louisville, Ky.; Chicago Pulley & Shafting Co., Chicago, Ill.; Cork Insert Co., Boston, Mass.; Dodge Manufacturing Corporation, Mishawaka, Ind.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; Ohio Valley Pulley Works, Maysville, Ky.; Pyott Foundry Co., Chicago, Ill.; Reeves Pulley Co., Columbus, Ind., and Saginaw Manufacturing Co., Saginaw, Mich.

The American Pulley Co., Philadelphia, Pa., has also developed a new pressed steel hanger. The main frame is constructed of two stampings placed face to face with inturned flanges extending the entire length of the leg. The cross brace is integral with the legs. The feet are made of cold-drawn, seamless metal and are riveted to the legs. The hanger is of the parting type, with a swing yoke which greatly facilitates the work of putting up or taking down shafting, or installing or removing bearings.

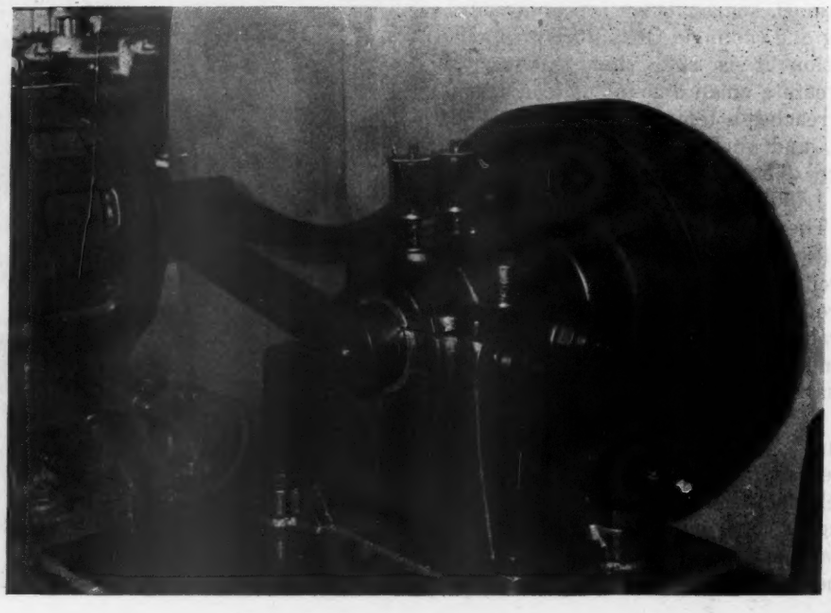
Dodge Manufacturing Corporation, Mishawaka, Ind., have recently made several important changes in the design and construction of their steel hanger. For example: A malleable-iron foot of ample proportions is now used and provides a broad, solid bearing. This casting projects downward a considerable distance on the frame, which adds a great deal to the rigidity of the hanger, and is securely riveted to the frame, which is of box construction welded and riveted together. Formerly the ring oiling bearing was the only type that could be furnished with this hanger. However, it is now possible to use the same type as formerly employed only rings for either ring or capillary oilers. This has been accomplished by a change in construction that permits the insertion of either rings or capillary blocks. The four-point adjustable feature provides for an ample range of adjustment.

Chain Drives

Silent chain drives have found a definite place in power transmission work, and in many cases this type of drive offers decided advantages. For example, silent chains are being widely used for individual drives for machines, particularly when the distance between driving and driven shafts is short. Chain drive is also being used between lineshafts or between lineshafts and countershafts when these are on short centers.

The Ramsey Chain Co., Inc., Albany, N. Y., has recently placed on the market a new design of silent chain, the chief feature of which is the compensating joint. There are two pins in each joint and the profile of the pins is such as to allow them

Chain drives are widely used where the distance between driving and driven shafts is short. Here a 100-hp. motor is driving a large fan.



to move toward each other, as the chain meshes with the sprocket, thus decreasing the effective pin diameter and increasing the pitch of the link to compensate for the accelerative impulse. This chain may, it is claimed, be run in either direction with equal facility and efficiency. A description of the various types of chains, with considerations governing their selection, application and care was given in the July, August and September, 1923, issues of INDUSTRIAL ENGINEER.

Companies which have been responsible for present developments in chain drives are:

American High Speed Chain Co., Indianapolis, Ind.; The Baldwin Chain & Manufacturing Co., Worcester, Mass.; Cullman Wheel Company, Chicago, Ill.; Diamond Chain & Manufacturing Co., Indianapolis, Ind.; Duckworth Chain & Manufacturing Co., Springfield, Mass.; The Jeffrey Manufacturing Co., Columbus, Ohio; Link-Belt Co., Chicago, Ill.; Morse Chain Co., Ithaca, N. Y.; The Whitney Manufacturing Co., Hartford, Conn.

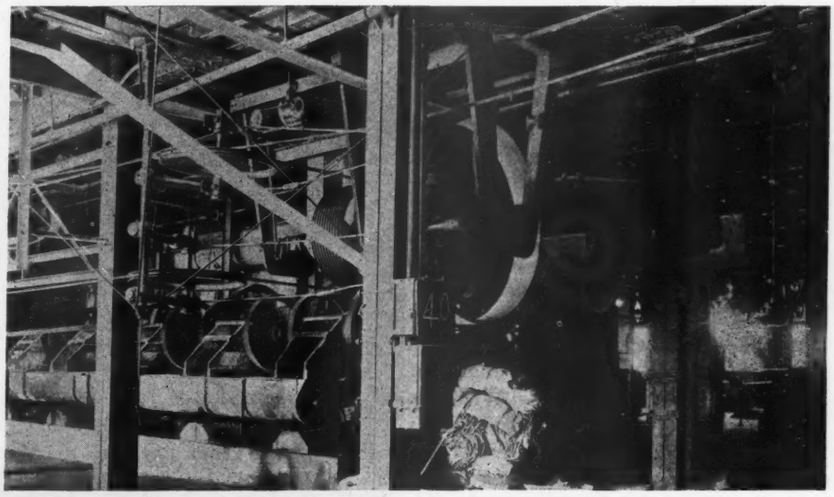
Clutches, Couplings and Speed Reducers

In new installations of power service equipment there is a growing tendency to use friction clutches more extensively than was formerly the case. These devices have been much improved during the past few years and this improvement has doubtless been an important factor in promoting their use. Realization by industrial engineers that a good deal of power can be wasted by running line- and countershafting idle has also contributed to a wider use of clutches and they are now being extensively used for disconnecting idle shafting and machines. In some new installations machines which do not have to be reversed or require changes in speed are being driven directly from the lineshaft by means of a friction clutch pulley. By this arrangement countershafts and belts are eliminated at a saving in power and maintenance charges as well as in first cost, with increased safety to the operator. Some machine tool manufacturers are now using a clutch on the driving pulley of their machines and eliminating the loose pulley.

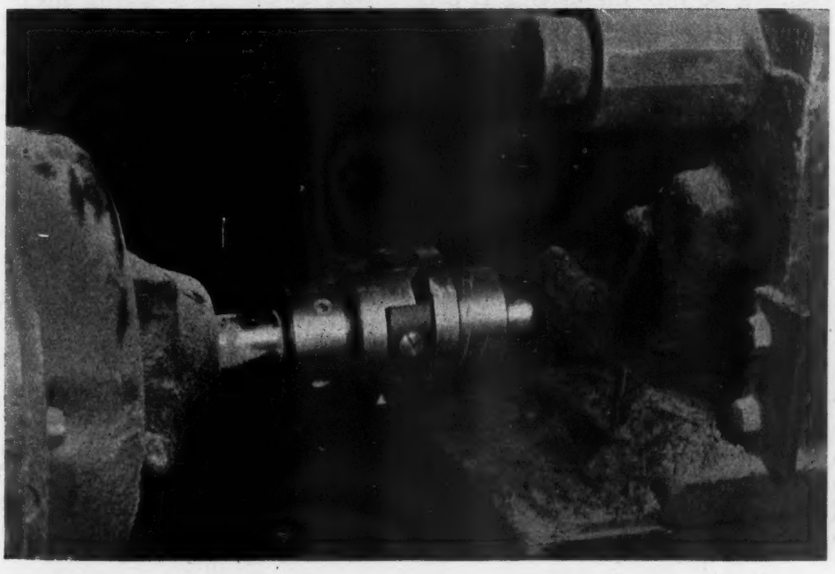
Among the new developments in this line of equipment is a multiple friction disk countershaft which is being marketed by the Warner & Swasey Co., Cleveland, Ohio. This countershaft is equipped with clutches having multiple friction disks, similar to the clutches employed in automobile construction. Hardened steel plates are employed in the clutch members.

The W. A. Jones Foundry and Machine Co., Chicago, Ill., has placed on the market the Lemley friction clutches and friction clutch pulleys. This clutch is of the well-known disk type. The friction disks are full floating loose fiber or burn-proof asbestos rings. One ring-nut adjusts all of the toggles, so that uniform pressure all around on the friction surface is assured.

When applied to pulleys the general design of the clutch is the same as for sleeve and coupling clutches, with the exception that provision is made for bolting the clutch to the pulley arms.



Belt, chain and rope drives operate side by side in this cement mill.



On direct drives a flexible coupling performs the important service of absorbing shocks, as well as transmitting power. The illustration shows the Higgins flexible coupling, manufactured by the Tomkins-Johnson Co., Jackson, Mich.

For a discussion of the various types of friction clutches and friction clutch pulleys, the reader should consult the article, Construction Details and Use of Clutches and Cutoff Couplings, in the January, 1924, issue of INDUSTRIAL ENGINEER.

Companies which have been active in the development of friction clutches are included below with those which have contributed to the development of couplings.

When the disadvantages connected with the old-time group drive, wherein all of the machine equipment was driven through lineshafting by one prime mover, were realized and individual drive was proposed, it was

hailed as a sort of cure-all for all operating troubles. The pendulum of opinion and practice then swung from one extreme to the other. Many engineers adopted the view that in place of driving all of the machines in a plant by one or two engines or motors, each machine should, whenever possible, have its own individual motor. Countless installations have been laid out on this basis.

More recently there has been a wider recognition of the fact that individual drive is not altogether free from undesirable features. The merits and disadvantages of individual drive and group drive will be thoroughly discussed in INDUSTRIAL ENGINEER in a series of articles, the first of which appears on page 56 of this issue.

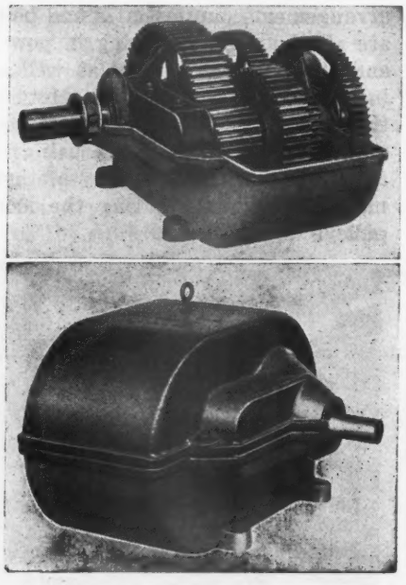
The tendency in recent installations has been to drive small groups of machines, preferably those which are turning out a similar product and can be operated as a unit, such as punch presses, automatic screw machines, and so on, from a single motor. If the individual machines are driven directly from the line-shaft through friction clutches or clutch pulleys, there can be obtained a drive which has most, if not all, of the advantages of individual drive, with few of its disadvantages.

When individual drive is used it is generally necessary to employ some form of flexible connection between the motor shaft and the shaft of the machine, in order to avoid shocks to and possible breakage of some of the moving parts. With the applications of direct drive to various kinds of machines, flexible couplings find an extensive field of usefulness. Several improved designs of flexible couplings have recently been placed on the market and deserve mention.

The Falk-Bibby coupling, manufactured by The Falk Corporation, Milwaukee, Wis., transmits power between two flanges by means of especially-constructed grid springs of tempered steel. True flexibility is obtained from the elastic properties of these springs, and the coupling is said to be capable of withstanding an unusual degree of parallel and angular misalignment of the shafts. The special feature of this coupling is, however, its torsional resiliency and consequent shock-absorbing properties obtained from the action of the springs, which engage with specially constructed grooves around the periphery of the flanges. These grooves fit the springs at the ends farthest apart, but flare towards each other.

The working parts of the coupling are enclosed in a floating shell which is packed with lubricant. The shafts can be aligned easily and can be disconnected in a few moments by simply releasing the shell and removing the springs around the periphery of the flanges.

Smith & Serrell, Newark, N. J., have developed and placed on the market a new fractional horsepower (¼ hp. to 1 hp.) flexible coupling. This is a three-part, all-metal coupling, consisting of two similar flanges and a laminated spring cross.



Mill-type speed reducer developed by the Palmer-Bee Co., Detroit, Mich.

This spring cross fits into and connects the projecting parts of the flanges, so that the driving is done silently through the springs. This coupling is flexible in all directions, as well as extensible endwise.

This company has also recently put out a high-speed type of flexible coupling for turbine drives. This coupling consists of two similar forged steel flanges which are attached to the shaft ends in the usual manner. Between these flanges, and bolted to them, is the flexible member which carries on its periphery a number of projecting bundles of laminated steel springs. These spring bundles fit into movable slotted bushings or keepers in the outer member of the coupling. These keepers can rotate as well as slide endwise in this outer member and inasmuch as the bundle of springs can slide up or down in the keepers, flexibility of the coupling in all directions is obtained.

Charles H. Clark, New York, N. Y., has recently developed a flexible coupling which is claimed to combine strength, durability, flexibility and adaptability to a wide range of work. The hubs are finished all over and each has a triangular-shaped face which forms three projections or teeth. These teeth fit into and are enclosed by a housing made in three pieces, which serves to transmit the power from one hub to the other. The joints between the separate portions of the housing are secured by bolts fitted with locknuts and carrying leather washers at each end, to give flexibility. Further flexibility may be secured by inserting in each housing a piece of steel-faced automobile brake lining to cover the acting portion of the tooth.

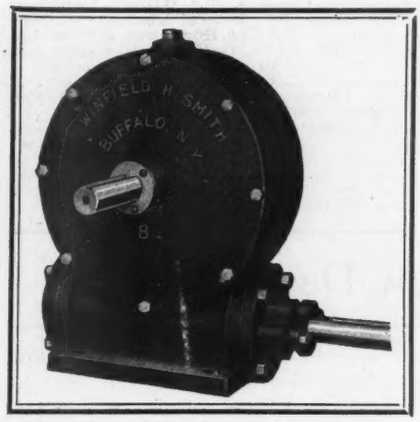
The Tomkins-Johnson Co., Jackson, Mich., is also putting on the market a new flexible coupling, the Higgins. This consists of two flanged members, one of which is fastened to each shaft, and a third member which transmits the power between the other two members. Lugs on the shaft members fit into slots in the middle member in such a way that both angular and axial misalignment of the shafts is permissible.

Descriptions of the various types of rigid and flexible couplings, with pointers on their selection and application, have been given in the October, November, and December, 1923, issues of INDUSTRIAL ENGINEER.

The following companies have been largely responsible for the development of friction clutches and rigid and flexible couplings:

Ajax Flexible Coupling Co., Westfield, N. Y.; Allis-Chalmers Mfg. Co., Milwaukee, Wis.; The Bartlett Hayward Co., Baltimore, Md.; Charles Bond Co., Philadelphia, Pa.; Bond Foundry & Machine Co., Manheim, Pa.; Brown Engineering Co., Reading, Pa.; The Carlyle Johnson Machine Co., Manchester, Conn.; Chicago Pulley & Shafting Co., Chicago, Ill.; Conway & Co., Cincinnati, Ohio; The Cutler-Hammer Mfg. Co., Milwaukee, Wis.; I. H. Dexter Co., Goshen, N. Y.; Dodge Manufacturing Corp., Mishawaka, Ind.; Falls Clutch & Machinery Co., Cuyahoga Falls, Ohio; The Falk Corporation, Milwaukee, Wis.; General Electric Co., Schenectady, N. Y.; The Hanson Clutch & Machinery Co., Tiffin, Ohio; The Hill Clutch Co., Cleveland, Ohio; The Hilliard Clutch & Machinery Co., Elmira, N. Y.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; The Medart Co., St. Louis, Mo.; Mesta Machine Co., West Homestead, Pa.; The Moore & White Co., Philadelphia, Pa.; The Never-Slip Clutch Co., Noblesville, Ind.; R. D. Nuttall Co., Pittsburgh, Pa.; The Pusey & Jones Co., Wilmington, Del.; Reeves Pulley Co., Columbus, Ind.; R. H. & F. M. Roots Co., Connersville, Ind.; A. L. Schultz & Son, Chicago, Ill.; Smith & Serrell, Newark, N. J.; Thomas Flexible Coupling Co., Warren, Pa.; Weller Mfg. Co., Chicago, Ill.; Western Engineering & Mfg. Co., Chicago, Ill.; The Williams Foundry & Machine Co., Akron, Ohio; T. B. Wood's Sons Co., Chambersburg, Pa.

In many instances the speed at which the shaft of a machine should be driven is below a practicable motor speed. If it is desired to use direct drive, recourse must be had to some form of speed-reducing or variable-speed transmission device. New developments in speed-reducing devices include the Palmerbee mill type reducer, which has been put on the market by the Palmer-Bee Co., Detroit, Mich. This reducer is intended for use with conveying machinery, steel mill machinery, heavy shears, presses, and so on. Speed reduction is obtained through a train of spur gears, compounded to obtain the desired speed, and enclosed in a cast-iron housing. Wide face, coarse pitch gears are used, giving maximum strength and all shafts are supported by a bearing at each end.



Small speed-reducing unit made by Winfield H. Smith, Buffalo, N. Y.

An unusual design of variable-speed transmission has recently been developed by The Oilgear Co., Milwaukee, Wis. This consists essentially of a variable displacement pump which delivers oil to a constant displacement motor. When the stroke of the pump is set at a maximum it delivers a fixed quantity of oil to the motor and forces the latter to rotate at a speed equal to that of the pump. As the stroke of the pump is reduced the amount of oil pumped is decreased and the motor will rotate more slowly. Any desired speed of the motor shaft from zero to the full speed of its pump shaft may thus be obtained, merely by changing the stroke of the pump. Change of speed, as well as change of direction of rotation, is made by manipulating a control wheel. This variable speed transmission is provided with an automatic overload gear, which protects both it and the driven machine from damage due to overloads.

A speed-reduction gear in which the shafts are kept in line and which uses no toothed gears for ordinary speed ratios has recently been placed on the market by George Smith Morison, Pittsburgh, Pa. This gear has been built to give a reduction as high as 90,000 to 1 and can be made to give any ratio desired. In its simplest form this reduction gear consists of a high-speed shaft on which are mounted three or four plain cylindrical rollers, two of which are mounted in plates or disks which are in turn integral with the slow-speed shaft. Surrounding and enclosing the roller is a circular ring, which is in contact with the rollers on its inner face. When three rollers are used one is made larger than the others. This gives the ring an eccentric motion.

The central driving shaft is in contact with the rollers and when it rotates it causes them to roll around with it in the same direction and turn the slow-speed or driven shaft. For larger ratios of reduction than can be had with rollers alone a combination of the eccentric roller principle with epicyclic teeth gears is used. The outside face of the ring is turned to two diameters, with teeth cut in each face. The teeth of one of the faces of the ring is meshed into the teeth cut on the inside face of another ring surrounding it and fixed rigidly in the body of the casing.

Winfield H. Smith, Buffalo, N. Y., has recently placed on the market several new sizes of worm-gear speed reducing units. These units are capable of transmitting up to 3 hp. Some of the features of design are thrust ball bearings, large babbitt radial bearings on high-speed shaft, and stuffing boxes to prevent leakage of oil.

The calculation of gear trains, with a description of the different types of speed reducers on the market and their application, was given in the February and March, 1923, issues of INDUSTRIAL ENGINEER.

Speed control of this lathe for turning elevator shafts and drums is obtained by the use of the Oilgear variable-speed hydraulic power transmission, manufactured by The Oilgear Company, Milwaukee, Wis.

The following companies have contributed to the development of gears and speed-reducing devices:

Boston Gear Works, Norfolk Downs, Mass.; The Chicago Rawhide Mfg. Co., Chicago, Ill.; Christiana Machine Co., Christiana, Pa.; The Cleveland Worm Gear Co., Cleveland, O.; The Falk Corporation, Milwaukee, Wis.; Farrell Foundry & Machine Co., Buffalo, N. Y.; Fawcus Machine Co., Pittsburgh, Pa.; Foote Bros. Gear and Machine Co., Chicago, Ill.; William Ganschow Co., Chicago, Ill.; General Electric Co., Schenectady, N. Y.; The Horsburgh & Scott Co., Cleveland, O.; D. O. James Manufacturing Co., Chicago, Ill.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; The Meachem Gear Corporation, Syracuse, N. Y.; New Process Gear Corporation, Syracuse, N. Y.; Niles-Bement-Pond Company, New York, N. Y.; R. D. Nuttall Co., Pittsburgh, Pa.; Philadelphia Gear Works, Philadelphia, Pa.; The Poole Engineering and Machine Co., Baltimore, Md.; Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

Miscellaneous New Developments

Smith & Serrell, Newark, N. J., have recently put on the market the Keytite self-fitting key, for making the driving connection between shafts and couplings, pulleys, gears, and the like. These keys are made of a tough chisel stock and are ground to a size very slightly larger than the nominal keyway width. A cutting edge and chip recess are provided near the front end of the key. Ahead of these is a pilot slightly smaller than the nominal keyway width.

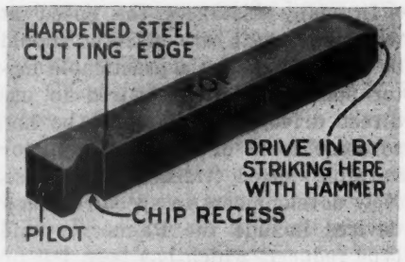
To install one of these keys the pilot is entered first with the cutting edge at the side. Then the key is driven home with an ordinary machinist's hammer or with a sledge, depending upon the size of the key. The cutting edge sizes the keyways to make a tight fit between the body of the key and the keyways. In the larger sizes cutting edges are sometimes provided on both sides and on top.

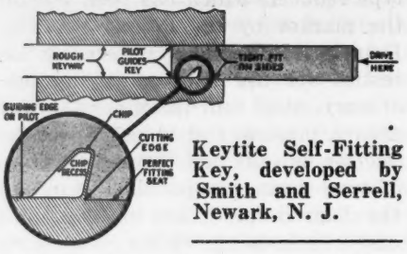
A new method of applying lubricating grease under high pressure to several bearings, through pipeline connections, has been developed by the Keystone Lubricating Company of Philadelphia, Pa. It is claimed that by this method of lubrication, bearings which otherwise would be difficult of access on account of small clearances between working parts, heat, and other unfavorable conditions can be reached easily. The device by which lubricating grease is delivered simultaneously to several bearings is known as the Keystone manifold safety lubricator. The lubricator, which is essentially a large cylinder into which is screwed a grease magazine fitted with a screw plunger, is of heavy, cast-iron construction. The magazine holds 8 lbs. of grease.

As a result of a recent change in the Underwriters' specifications which allows the use of single-stage centrifugal pumps for fire protection, the Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has brought out a new single-stage pump. This pump is a modification of a special high-head type of single-stage pump which has been built for some years and meets the Underwriters' requirements.

Types of fire pumps used with the Underwriters' requirements governing installation were described in the December, 1922, issue of INDUSTRIAL ENGINEER.

Speed reduction gear designed by George S. Morison, Pittsburgh, Pa.
This reducer uses rollers for low speed ratios as shown at the left. For high speed ratios an epicyclic gear train is used in combination with the rollers (right), as described more fully in the text on page 67.





Keytite Self-Fitting Key, developed by Smith and Serrell, Newark, N. J.

The following companies have played an important part in the development of pumps for fire and other service:

Allis-Chalmers Manufacturing Co., Milwaukee, Wis.; Buffalo Steam Pump Co., Buffalo, N. Y.; Dayton-Dowd Co., Quincy, Ill.; DeLaval Steam Turbine Co., Trenton, N. J.; The Goulds Manufacturing Co., Seneca Falls, N. Y.; Northern Fire Apparatus Co., Minneapolis, Minn.; Twinvolute Pump & Manufacturing Co., Inc., Newark, N. J.; Worthington Pump and Machinery Corporation, New York, N. Y.

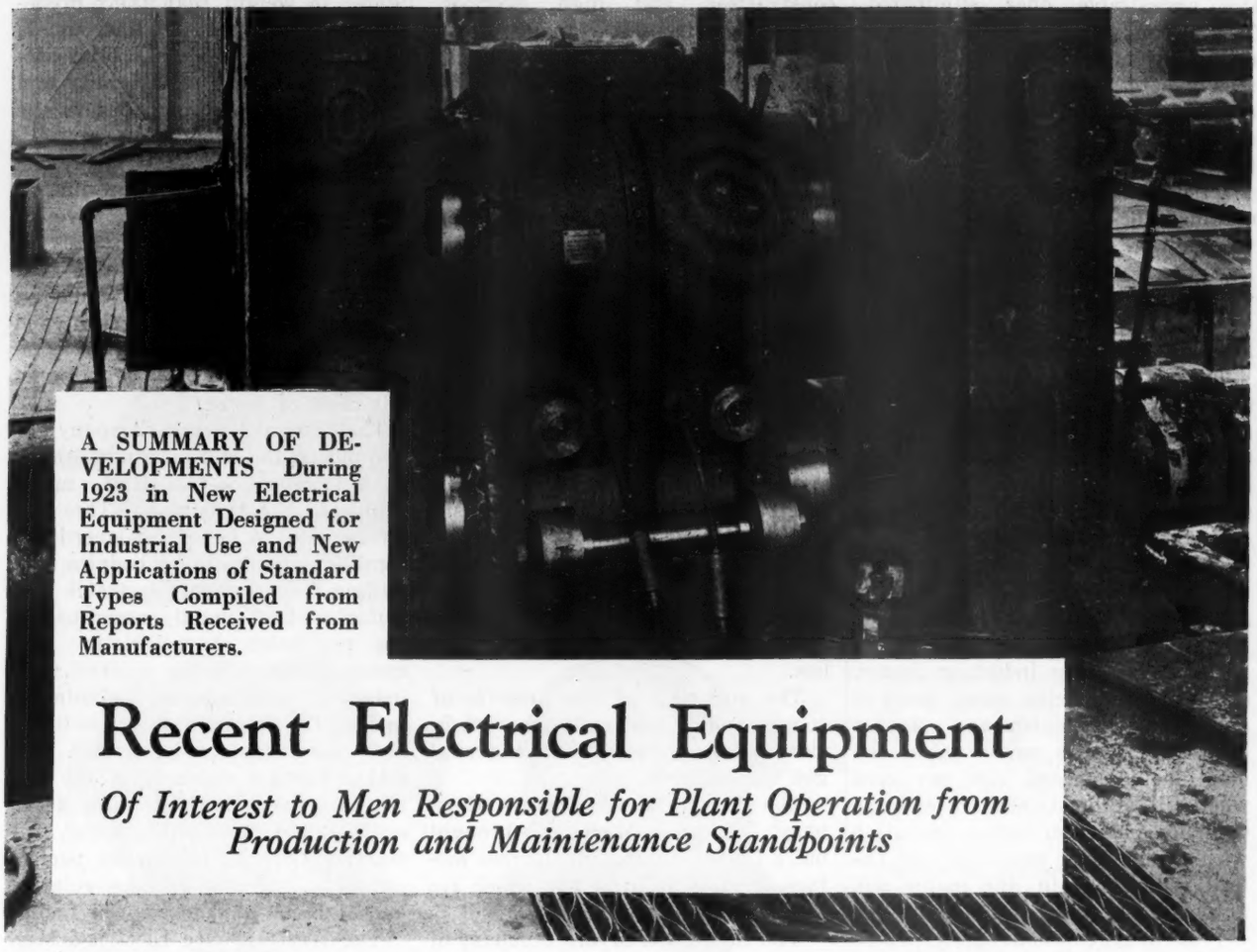
In addition to the developments mentioned above, several other companies have brought out new devices or improvements on existing equipment which are of interest to industrial engineers.

The Surty Manufacturing Co., Inc., Chicago, has put on the market an automatic and a semi-automatic cone belt shifter. This device eliminates the risks involved in shifting belts by hand and reduces the time required.

An outfit known as the Multiblaster has been brought out by George M. Stowe, Jr., Buffalo, N. Y. It is adapted for spray painting and sand blasting and for cleaning machinery and equipment in general with any solvent.

This outfit has been developed for all-around use in industrial plants. It is light in weight and portable, with a capacity limited only by the size of the container utilized for the liquids to be applied, or the size of the sand pile. The device is attached to air lines at any point near the work.

W. N. Matthews Corporation, St. Louis, Mo., is marketing mechanical painting units consisting of air compressor, electric motor, air reservoir and so on, mounted on a small truck for ready transportation to any desired location. These spray painting outfits can be made for gasoline-engine drive. (*Continued on page 101*)



A SUMMARY OF DEVELOPMENTS During 1923 in New Electrical Equipment Designed for Industrial Use and New Applications of Standard Types Compiled from Reports Received from Manufacturers.

Recent Electrical Equipment

Of Interest to Men Responsible for Plant Operation from Production and Maintenance Standpoints

By ARTHUR J. WHITCOMB
Associate Editor, Industrial Engineer

THROUGHOUT 1923 electrical manufacturers have increased their volume of production in practically all classes of apparatus and in many cases the output has exceeded the maxima of war-time. High-pressure production is not usually conducive to radical changes in design and a considerable proportion of the improvements reported have been along conventional lines. There have been, however, a number of distinctive new developments which represented advances in the art. These took place not only in the industrial field but also in the transportation and public utility fields. It is the purpose of this article to summarize those of interest to the industrial user. Since this is a review of new applications of old equipment as well as recent developments in new equipment it will of necessity include machines and materials other than those developed only during the year 1923.

During the past year the Electric Power Club, which is an association of manufacturers of electric power apparatus and control equipment, has reprinted its handbook of standards and included all revisions and new additions up to October, 1923. These standards include new information on standard sizes of outlet or conduit terminal boxes for motors and standards for synchronous motors and new standards covering d. c. arc welding machines. Revised electric drill standards are given which are more severe than standards previously adopted. Details are included also on outdoor construction for single-phase and three-phase distribution and power transformers. Standard definitions are given for power switchboards and similar information for oil circuit breakers. The Electric Power Club during the year has also published rules for the installation, operation and care of motors and generators. These rules were published in the July and November issues of INDUSTRIAL ENGINEER.

Electric roll heater made by Freyn Brassert & Company, Chicago, Ill.
This heater is used for preheating the finishing rolls of sheet and tin mills.

Industrial Motors

Marked activity has been noticed in the development of industrial motors. This is not only along the lines of perfecting and rounding out lines of apparatus already developed, but in the design of new motors with better operating characteristics and higher efficiencies. Owing to the large number of motor applications in modern industrial plants, every detail of improvement in the operation or application of individual motors is of far-reaching economic value when considered in the aggregate.

Induction Motors.—The Wagner Electric Corporation of St. Louis, Mo., has developed a new motor known as the Fynn-Weichsel motor which combines the good characteristics of slip-ring induction and synchronous motors with most of

the undesirable ones eliminated. This motor is designed to operate at unity power factor—or when operated where induction motors are also used it can be adjusted to so compensate for the lagging current taken by the induction motors that practically unity power factor is obtained for the entire installation. In addition the makers point out that the Fynn-Weichsel motor develops a high starting torque with a starting current that is relatively low.

The stator and the rotor of this motor each have two windings. The rotor has slip-rings and a commutator. The commutator is used to obtain exciting current for one of the stator windings. The manufacturer claims that no commutator trouble is experienced, as the commutated voltage is very low—on the order of fifteen volts. It is also stated that the motor starts in a manner similar to a slip-ring induction motor, and as it approaches rated speed it pulls into synchronism and operates as a synchronous motor unless the load should exceed 150 per cent when it automatically reverts to slip-ring induction motor operation with about 3 per cent slip. If the load reduces again, the motor will automatically pull into step and operate at synchronous speed. These characteristics in a single motor represent a marked achievement in engineering design that should give this motor a wide application in industrial work.

The Reliance Electric and Engineering Company of Cleveland, Ohio, has put on the market a new squirrel-cage, polyphase induction motor known as type AA. The points featured in this motor by the manufacturer are the insulation of the stator windings, bearings, rotor construction and high overload torque capacity. It is pointed out that the stator punchings are assembled under ten tons pressure and then hot-riveted. The contraction of rivets in cooling aids in securing a tight and rigid core. The end flanges are ribbed to give greater strength and support to the stator laminations. The feet are cast integral with the flanges which are heavy and solid in order to reduce vibration and prevent loosening of feet from frame.

The stator coils are wound of cotton-covered enameled wire. The manufacturer states that the armature, after being wound, is treated and baked three times and then given a coat of air-drying varnish. The special insulation and the thorough dipping and baking, the maker points out, produces windings that resist the destructive influences of dirt, moisture, oil, acids, and alkalies.

The end ring of the rotor is of copper and is cast on to the extensions of the bars to provide a rugged construction.

The Marble Card Electric Company, Gladstone, Mich., has brought out a line of alternating-current motors, in sizes up to 25 hp., which are equipped with ball bearings.

The Robbins & Myers Company of Springfield, Ohio, has put on the market a new polyphase, squirrel-cage motor known as type L. While these motors are smaller in size and lighter in weight than their predecessors, the type K line, it is claimed that nothing has been sacrificed in strength and rigidity and much has been accomplished in the way of improved performance.

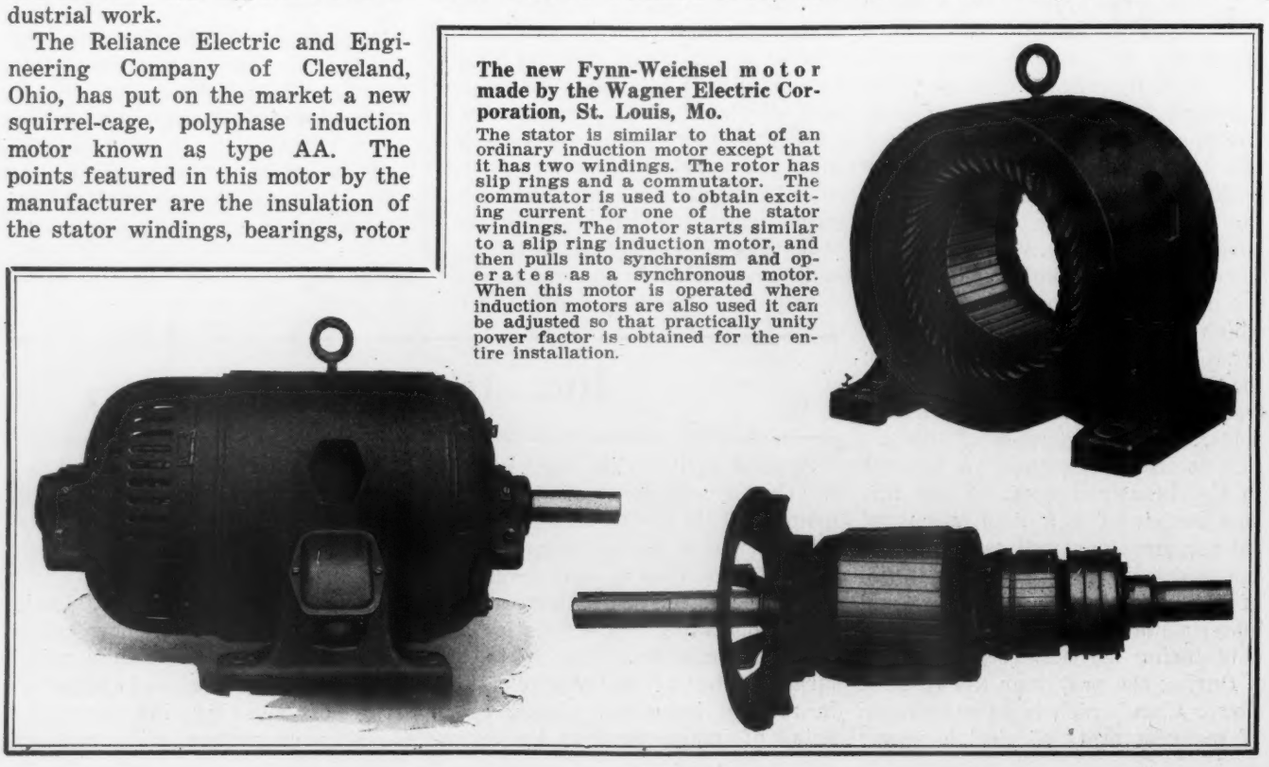
The General Electric Company has brought out a complete new line of 40-deg., continuous-duty, riveted-frame polyphase motors in sizes up to 15 hp. The maker states that this new line of motors embodies numerous improved electrical and mechanical characteristics as compared with previous construction of this class of motor.

The General Electric Company has also put on the market a new single-phase, repulsion-induction motor known as the type SCR. This motor is said to be of "balanced design"—a composite embodying the leading features most desirable in a motor without unduly accentuating any particular characteristic. The motor operates on the squirrel-cage, induction principle and eliminates entirely the short-circuiting switches heretofore considered essential. The maker further claims that the motor has a very high starting, accelerating and "pull out" torque, low starting current, practically perfect commutation, close speed regulation and high efficiency and power factor.

The Westinghouse Electric & Mfg. Company reports that its line of fractional horsepower type ARS repulsion motors has been completed and includes improvements which

The new Fynn-Weichsel motor made by the Wagner Electric Corporation, St. Louis, Mo.

The stator is similar to that of an ordinary induction motor except that it has two windings. The rotor has slip rings and a commutator. The commutator is used to obtain exciting current for one of the stator windings. The motor starts similar to a slip ring induction motor, and then pulls into synchronism and operates as a synchronous motor. When this motor is operated where induction motors are also used it can be adjusted so that practically unity power factor is obtained for the entire installation.



(A) is an a.c. adjustable-speed, brush-shifting motor made by the General Electric Company. (B) is a totally-enclosed induction motor developed for oil well service by the same company. (C) is a new polyphase induction motor made by Robbins & Myers Company of Springfield, Ohio. (D) is the new type SCR single-phase, repulsion-induction motor made by General Electric Company. (E) is the new type AA polyphase squirrel-cage induction motor made by Reliance Electric and Engineering Company of Cleveland, Ohio.

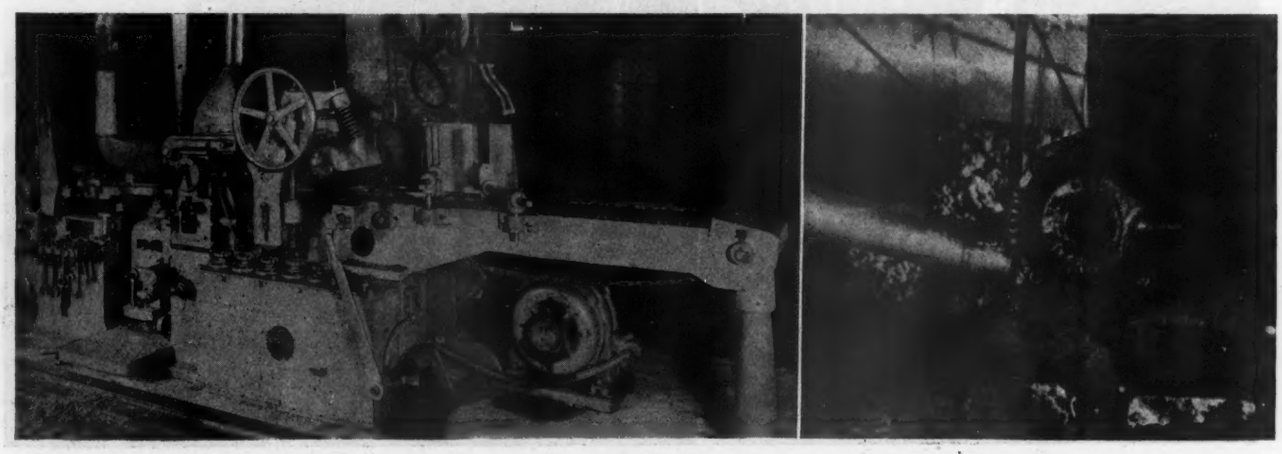
increase the operating life. This company further states that its line of single-speed and three-to-one speed squirrel-cage, elevator motors has been improved so that the motors are practically noiseless and have increased starting torque. A totally-enclosed, self-ventilated motor for fire pump service has been developed.

The American Electric Motors, Inc., of Milwaukee, Wis., is making a line of totally-enclosed, self-ventilated motors for which is claimed a great saving in maintenance expense where the motor is required to work in dirty locations. The motor is equipped with large ventilating fans attached to the shaft, which draw clean air through an inlet pipe from an outside location. The maker claims that the motor is drip-proof, dirt-proof, splash-proof and is built for use in foundries, flour and grist mills, woodworking plants, textile mills; in fact all places where motors are causing trouble from adverse atmospheric conditions.

The Triumph Electric Company, Cincinnati, Ohio, states that industrial plants can reduce maintenance and initial costs by the use of its self-starting, automatic, type TR motor. The TR rotor has a high-resistance winding which is used for starting but remains active as long as the stator is excited. There is also on the rotor a low-resistance winding which becomes active only after the rotor has reached a predetermined speed and at this speed is activated by the operation of a centrifugal governor. The maker claims that this motor is different from the ordinary squirrel-cage motor in that the TR motor gives a very high starting torque with a limited starting current, that the compensator is eliminated, and that the motor is not disconnected from the line during the acceleration period. It is further pointed out that due to the high starting torque, these self-starting motors can generally be applied with a rating based on full-load conditions; consequently no necessity for overmotoring exists. Hence the maker claims that first costs are reduced because no compensator is required and no necessity for overmotoring exists, and that maintenance costs are re-

Applications of motors in industrial plants where much dirt is encountered.

At the left is shown a wood-moulding machine driven by five motors. A special, drum-type interlocking control is used which is provided with thermal overload protection. This application was made by General Electric Company. At the right is a totally-enclosed, self-ventilated motor made by American Electric Motors, Inc., of Milwaukee, Wis. Clean air is piped to this motor and the exhaust air leaves through another pipe, so as not to stir up the dust in the surrounding atmosphere.



duced because there is no compensator or other similar starting device to maintain.

The B. A. Wesche Electric Company, Cincinnati, Ohio, manufacturers of "Uniframe" motors in sizes from ¼ to 50 hp., state that the company has standardized on a line of ball bearings for use in its motors. This is in addition to its regular line of sleeve-bearing motors.

The Hertner Electric Company of Cleveland, Ohio, has recently brought out a line of polyphase motors in sizes ranging from ½ to 50 hp. This manufacturer claims that this motor has a practically indestructible rotor made with trapezoidal rotor bars brazed to recesses in cast copper end rings. The rotor is built so that the shaft can be easily replaced. The maker refers to the following features of the sleeve bearings used in this motor: two oil rings are provided in every bearing; oil guards are provided which force the oil rings to resume correct position on shaft; a symmetrical bushing is used so that it may be reversed and give longer life; a special design of oil well causes the dirt to gravitate to the drain hole; a semi-self-aligning mounting is used for the bushing.

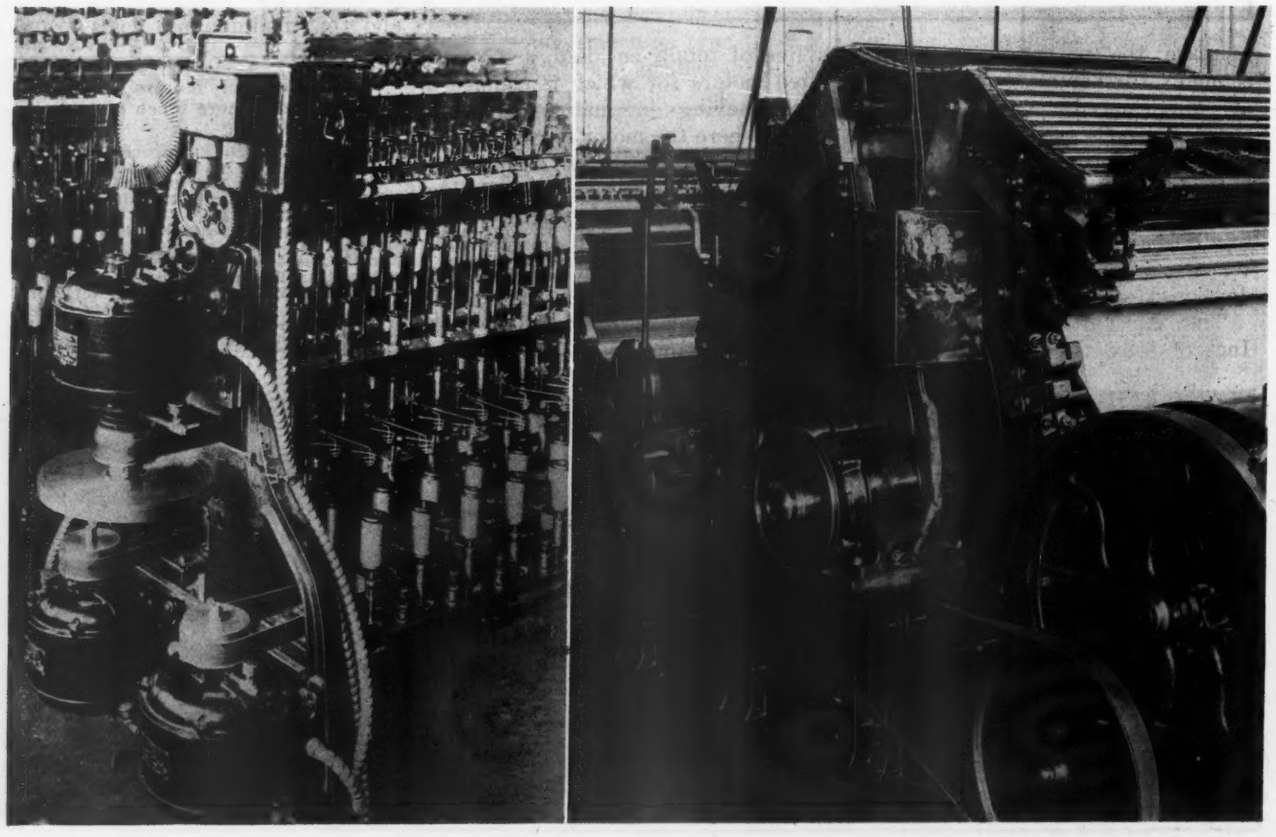
Synchronous Motors.—The Westinghouse Electric & Mfg. Company states that a new type of damper winding has been developed for high-speed synchronous motors, condensers and generators, which, in addition to simplifying the construction makes the machine capable of successfully withstanding much higher overspeeds than formerly. This manufacturer has built high-speed (650 hp., 3,600 r.p.m.) synchronous motors for driving multiple-stage, steam-turbine-type, air compressors. A 1,700 hp., 1,500 r.p.m. synchronous motor has also been built. The Westinghouse Electric & Mfg. Company has also extended the use of motor-driven gas compressors through the development of an enclosed type of collector to prevent the possibility of sparking at the brushes igniting the gas. The maker states that this has been accomplished by totally enclosing the rings in a sheet-steel drum through which air is forced by means of a separate, motor-driven blower.

Industrial Motor Drives

Textile Motor Applications.—The Westinghouse Electric & Mfg. Company states that during the past year it has made successful applications of motors and control to card drives, silk spinners, and tandem finishing machine drives, which offer distinct advantages and improvement in the operation of the machines. Two new and typical installations are shown below.

Steel Mill Motor Applications.—The Westinghouse Electric & Mfg. Company has recently built direct current, compound-wound motors rated at 240 volts, 1,500 hp., 125-250 r.p.m. and similar but larger motors rated at 1,800 hp., 165-350 r.p.m. These motors were used to drive the finishing stands of a 16-in. hot strip mill, each stand being driven by a separate compound-wound motor. The maker states that these motors are designed with such close inherent speed regulation that they operate throughout their speed range without any automatic, speed-regulating control. It is further pointed

Two new motor applications made by Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa.
At the left is shown the application of three motors per frame to a silk spinner. At the right, the application of individual motor drive to a cotton card.



out that this is the first installation of a drive for a continuous hot strip mill train which has been operated without special control for maintaining correct speed.

The General Electric Company has developed an alternating-current, brush-shifting motor with shunt characteristics. This company states that this motor, without auxiliary apparatus, gives adjustable speed that is practically independent of load. Machines of this type that are rated at 600/400/200 hp. 321/214/107 r.p.m., 25 cycles and 500/385/250 hp., 130/100/65 r.p.m., for the same power supply have recently been built for driving merchant mills. The General Electric Company states that the tendency towards the use of high-speed motors with reduction gears, which has been quite marked for the past few years, continues to gain headway and that over 90 per cent of the new motors for main roll drives are for geared service.

The Westinghouse Electric & Mfg. Company reports that orders have been received for five large main roll drives which are to replace the present steam drives. One of these drives consists of a 1,500-hp., 230-volt, 470-510-r.p.m. direct-current motor, a 1,000-kw. synchronous motor-generator set, a 75-hp. reel drive, and complete control. This set will replace the engine drive on the finishing stands of a rod mill. The roughing and intermediate stands of the mill are to be driven by the present engines, the speeds of which are subject to considerable fluctuation. It is pointed out that the automatic control which will be supplied for the 1,500-hp. motor will cause it to follow the variations in the speed of the engines, thus preventing breakage of the hot steel rod or damage due to excessive looping. Automatic control is also included for the rod reel drive which the maker says will allow the reels to take up the finished rod uniformly, regardless of the speed of the mill.

Paper Mill Motor Applications.—The Westinghouse Electric & Mfg. Company has installed and placed in operation during the year a sectional paper machine drive on one of the world's fastest paper machines, the paper speed being 1,200 ft. per minute. The motor equipment for this installation is rated at 50 to 150 hp., 265 to 700 r.p.m. This company has also built a 90 to 92-hp., 100-1,100-r.p.m motor which is the largest speed-range motor it has built for single-motor, paper-machine drive.

Oil Well Motor Applications.—It is essential that a motor for oil-well pumping be capable of meeting the widely different operating requirements of pumping, pulling and cleaning the wells and yet function efficiently when employed under these same conditions of operation. To meet these special requirements the Westinghouse Electric & Mfg. Company has developed a 35/15-hp., type CW two-speed, wound-rotor induction motor for three-phase, 440-volt, 50- or 60-cycle operation. Two of these motors are combined in the two-motor, oil-well drilling equipment which the Westinghouse Company says has been tried out with great success in the Mid-Continent oil fields.

The following advantages are claimed for this equipment:

1. A perfect drilling motion at all depths of hole.
2. Greater reserve power than available with steam engines.
3. Reduction of idle equipment at close of drilling program, since the same motors are used for both pumping and drilling.

To meet the requirements of the Russian Government in regard to electrical equipment for oil-well drilling, the General Electric Company has developed two totally-enclosed induction motors, rated at 75 hp. and 50 hp., 750 r.p.m. This company further states that these are the largest totally-enclosed, self-ventilated motors yet made; previous designs in these sizes employed water as a cooling agent.

Woodworking Motor Applications.—Several manufacturers of sawmill and woodworking machinery have designed new planers and matchers on which the motors are direct connected to the various spindles. The Westinghouse Electric & Mfg. Company states that it is supplying shaftless motors and controllers for this class of equipment. It is also mentioned that in all cases two motors are being used on the top planer head in order to obtain the necessary power without increasing the diameter of the motor. The Westinghouse Company is making shaftless induction motors as large as 30 hp. at 3,600 r.p.m. for this class of equipment. By the use of a small frequency changer for converting the 60-cycle supply to 120 cycles, a motor speed of 7,200 r.p.m. is obtained, which gives even greater production on a matcher or woodworking machine of that description.

During the year considerable work was done towards standardizing the bores of these small, shaftless motors. Through the efforts of several of the electrical companies, most of the tool manufacturers are now using a definite bore for the insertion of the shaft.

The DeWalt Manufacturing Company of Leola, Lancaster, Pa., has developed a "Dew-All" bench machine for handling a wide range of woodworking jobs. This machine has a motor mounted from an overhead swinging arm, so arranged that it can be swung into any desired position over the work bench. On one end of the motor shaft is a pulley and on the other is a clamp for attaching a circular saw that will do cross cutting, ripping, mitering, bevelling, matching, moulding, irregular shaping, dadoing, routing, sanding, boring, turning, fluting, tenoning, boring or panel raising on any rake or bevel.

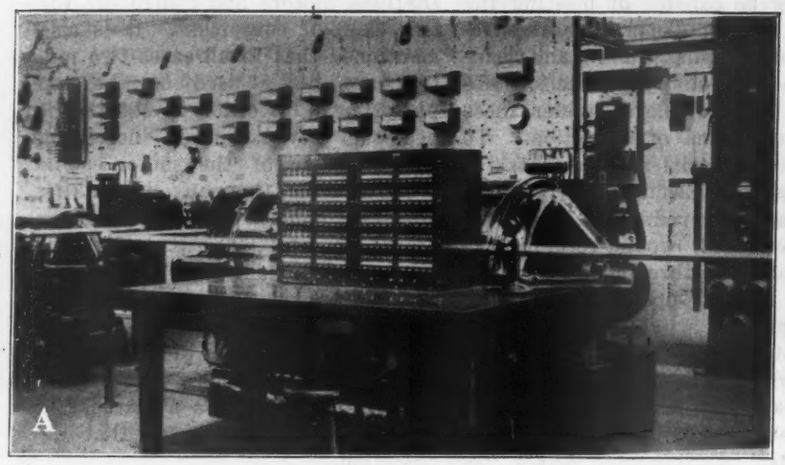
Electric Control Equipment

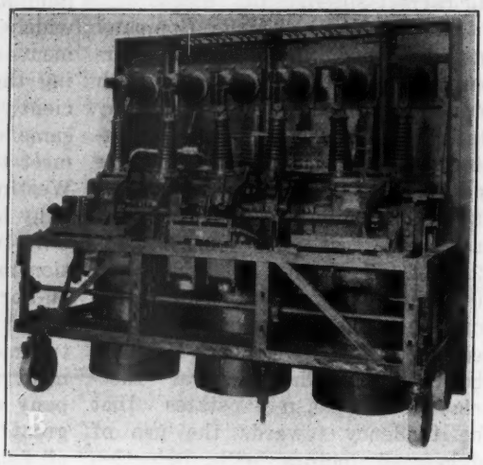
Motor Control.—The Westinghouse Electric & Mfg. Company reports that it has perfected an automatic synchronous motor control with dynamic braking that is obtained in a manner comparable to that used on direct-current motors and brings the motor to a quick but easy stop without shocks. This control, it is claimed, is particularly adapted for use on rubber mill motors which are often required to make a quick stop in an emergency. Reference is made to an installation of two 250-hp., 600-r.p.m., 2,200-volt, 60-cycle synchronous motors complete with this automatic control; in dropping from 600 r.p.m. to 0 r.p.m, the motors make only a little over two revolutions. The maker further states that this method of braking is more accurate than mechanical brakes and imposes smaller mechanical stresses on the machinery.

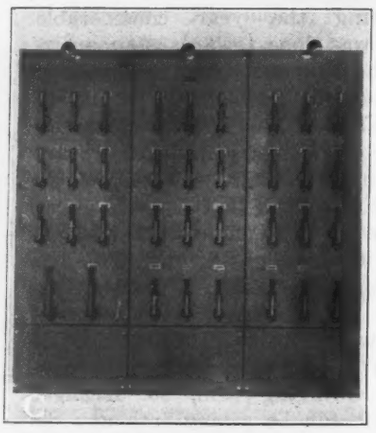
The Westinghouse Electric & Mfg. Company has also developed an alternating-current plugging control for a two-motor calendar drive. This

Typical Items of Industrial Control Equipment

Devised to Handle a Variety of Service Requirements







A—Supervisory equipment built by General Electric Co. for controlling feeders and apparatus at a distant substation.

B—Type FK-130 truck-mounted oil circuit breaker made by General Electric Co.

C—Front view of "Bull Dog" safety type industrial switchboard made by the Mutual Electric & Machine Co., Detroit, Mich.

D—Rear view of the same switchboard.

E—A 2,200-volt air-break, alternating-current magnetic contactor manufactured by Westinghouse Electric & Mfg. Co.

F—The new enclosed, self-ventilated motor for fire pump service built by the Westinghouse Electric & Mfg. Co.

G—Thermal relay type TR designed by the Automatic Reclosing Circuit Breaker Co., Columbus, Ohio.

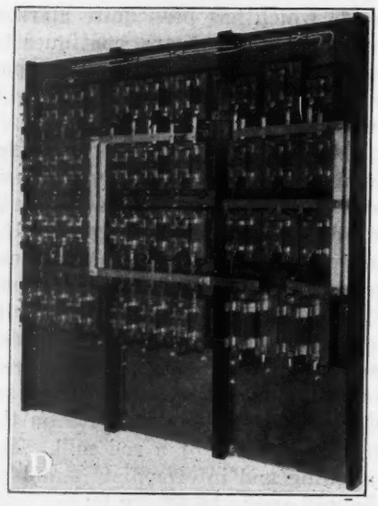
H—I-T-E synchronism actuated lock-out relay made by The Cutter Co., Philadelphia, Pa.

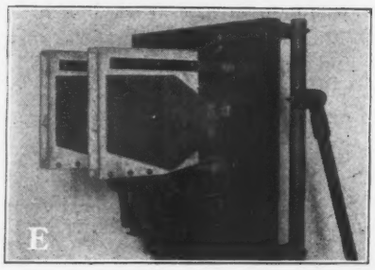
I—Type AF automatic auto-starter made by Westinghouse Electric & Mfg. Co.

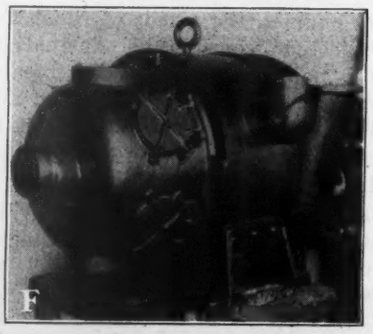
J—Type ZK manual-automatic compensator made by The Electric Controller & Mfg. Co., Cleveland, Ohio.

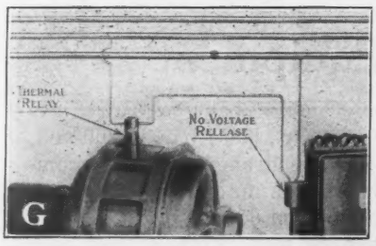
K—Primary-resistance, hand starter manufactured by General Electric Co.

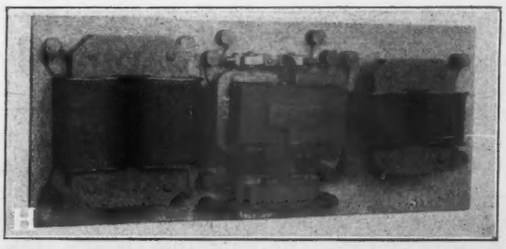
L—Automatic substation equipment installed underground in salt mine for controlling a synchronous motor-generator set. This equipment was made by General Electric Co.

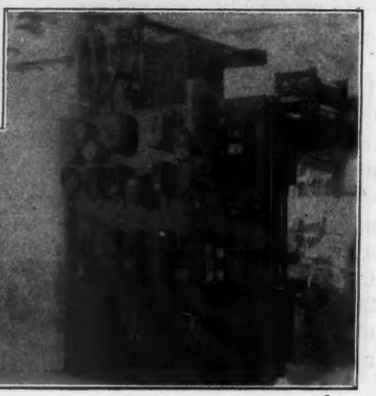


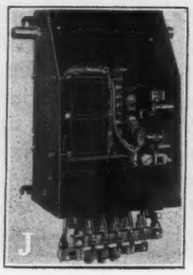


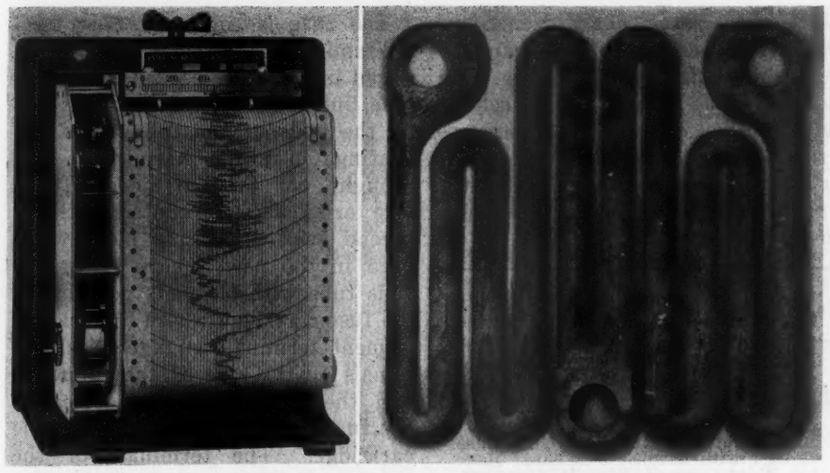












Two products of interest to the maintenance department.
On the right is a punched steel resistor grid made by the Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa. The graphic meter is made by the Esterline-Angus Company of Indianapolis, Ind. Instead of the usual clock drive for the chart, this meter is equipped with an electrically-operated drive by which any number of meters may be operated in synchronism with a master clock.

company has standardized its large printing control equipments. It has developed an alternating- and direct-current universal printing control, a five-pole, alternating-current contactor, a 2,200-volt, air-break, alternating-current magnetic contactor, and a new line of across-the-line starters for small squirrel-cage motors.

The Electric Controller & Mfg. Company of Cleveland, Ohio, has developed a new type ZK manual-automatic compensator. It is pointed out that this compensator disposes of the objectionable features of the so-called "hand compensator" and at the same time has all the good points, with the exception of remote control, of the automatic compensator. With the type ZK compensator it is necessary to throw the handle only to the starting position. The maker states that after the motor has accelerated to a speed where it can be safely thrown across the line, a relay operates a mechanism which automatically throws the compensator from the starting position to the running position. This compensator is equipped with inverse-time-element overload protection obtained by means of an expansion wire overload device which the maker claims protects against overload or excessive load due to single-phase operation of the motor.

The Westinghouse Electric & Mfg. Company has developed a type AF automatic auto-starter, arranged for push-button control. The maker claims that this automatic compensator accelerates the motor correctly, because definite time acceleration is employed.

A new enclosed automatic starter, the CR-7056-D1, of the primary-resistance type, has been developed by the General Electric Company for starting polyphase squirrel-cage induction motors under light load. The resistance of this starter is proportioned to give an inrush current of 3½ times the normal full-load motor current, permitting the motors to develop at least 50 per cent full load torque in starting. These starters are equipped with a single-step resistor, equal parts of which are connected in each phase. The switching elements consist of a starting contactor, a running contactor and a time-limit accelerating relay whose action is retarded by an alternating-current magnetic drag. Overload protection is provided by a thermal overload relay. The starter is of the safety type, completely enclosed with a ventilated case. The time interval of the closing of the accelerating relay can be changed from approximately three to eight seconds.

The Condit Electrical Mfg. Company of South Boston, Mass., has designed a thermal relay for use on its recently developed type N-4 motor starter. The thermal relay is made up somewhat similar in form to a fuse cartridge. This relay consists of a heat element around which is spirally wound a bimetallic strip. This strip is arranged to either open or close a contact when the heat element becomes hot enough to cause the spiral to unwind. The relay contacts are in series with either the undervoltage or shunt trip attachment and hence in case of overload will trip the motor free from the line. After an overload the relays automatically reset to the normal operating position.

The Automatic Reclosing Circuit Breaker Company of Columbus, Ohio, has also developed a thermal relay designated as type TR. This relay is designed to be universally applicable to any surface, including motors, small shaft bearings, station transformers, etc., from the temperature of which it may be desired to operate a relay. The bottom of the relay is fitted with a brass bulb in which is a sylphon element. When the temperature of the surface with which the brass bulb is in contact exceeds the temperature at which the relay is rated, the sylphon element expands and operates a push-button switch at the end of the relay. The standard relay is built to operate at 75 deg. C. The manufacturer states that the relay was designed to be placed on that part of the motor frame or stator laminations the temperature of which indicates the degree of heating to which an overload may subject the motor.

To assist in the standardization of resistor grids the General Electric Company has developed a type BG railway resistor which is interchangeable, both electrically and mechanically, with other resistors on the market. The unit consists of a sheet-steel punched end frame with sufficient holes to make possible its support on the same bolt hole centers as other generally used resistors. The convolutions of this new type resistor are said to be shorter than the General Electric CG and RG types; the grids are stronger and less likely to break or warp and the number of contacts is reduced to half.

The Westinghouse Electric & Mfg. Company has also completed a new line of punched steel grids for resistors. The maker claims that this type of grid is free from breakage and is economical in space. The Ward-Leonard Electric Company of Mt. Vernon, New York, has just put into production a fully-enclosed type embedded resistor for speed regulation duty.

For use where vibration and jars are likely to loosen the resistor from a standard screw socket, the Ward-Leonard Electric Company has developed a Vitrohm resistor unit with Edi-swan (bayonet lock) base. This resistor unit is made for reducing regular line voltage to meet the re-

quirements of so called "low-voltage" devices, used on motor-generator sets, industrial control, etc.

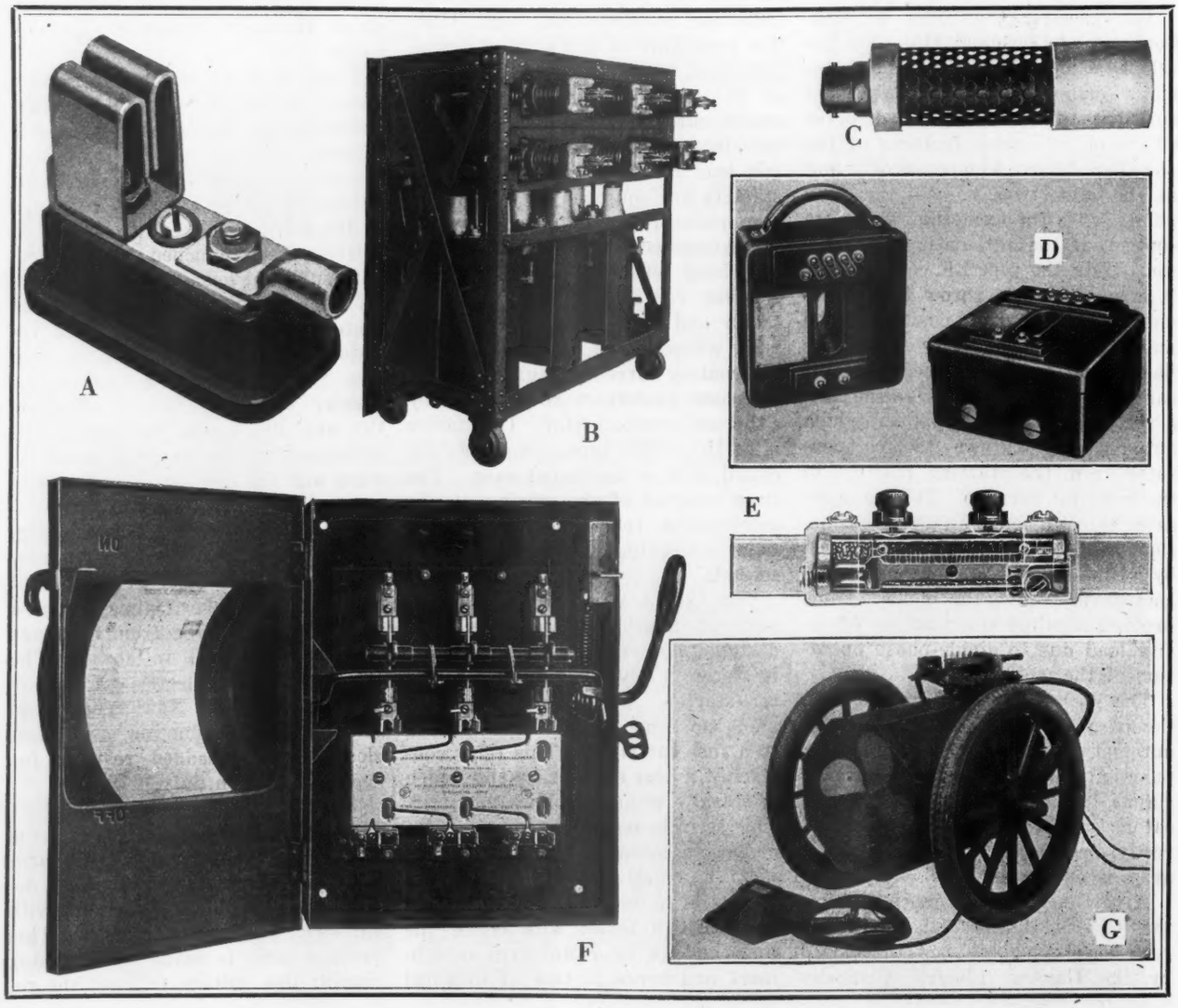
For the protection of three-phase motors against the evil effects of single-phase operation, the Westinghouse Electric & Mfg. Company has developed a negative-phase balance relay for the protection of all the essential auxiliary motors. The maker states that this relay is entirely new and so sensitive to single-phase operation that an unbalance of 10 per cent will create enough single-phase effect to trip the breaker.

The Federal Electric Company, Chicago, Ill., has recently developed a special type of back connecting block which fits in the unit type "Square D" line of switches. This block fits in between the fuse jaws on the switch. The block carries the back contacts and auxiliary wiring required for the use of the "Federal National Multiphase" time-limit, powder-packed fuse. The advantages claimed by the manufacturer for this fuse are: (1) Prevents single phase operation of motors. (2) A definite time delay before fuse will blow. (3) Fuse can be refilled with renewal element. (4) Fuse operates at lower temperature resulting from less potential drop over fuse and consequently fuse has very low power loss.

Recently developed products of interest to men in charge of maintenance in industrial plants.

(A) The unit base of moulded composition used in the Square D Switch shown at F. (B) Truck type circuit breaker made by Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. (C) "Vitrohm" tube resistor with bayonet lock base. Made by Ward-Leonard Electric Company, Mt. Vernon, N. Y. (D) Portable current transformer with range from 0 to 800 amp. Made by Esterline Angus Co., Indianapolis, Ind. (E) Fuse which protects motor from overloads or single phase operation. Made by Federal Electric Company, Chicago, Ill. (F) Safety switch with the unit type bases shown at A. Made by Square D Company, Detroit, Mich. The block shown between the fuse clips is the back connecting block made by the Federal Electric Company for use with its Multiphase fuse shown at E. (G) Portable arc welding generator made by the Liteweld Co., Cleveland, Ohio.

The fuse is composed of a fuse link and a heating element, both enclosed in a powder-packed tube. The fuse link terminals are brought out on the ends of the tube while the heating element terminals are brought out on the sides. These side terminals make contact with the special back connecting block when used in the new Square D switch. This tube with elements goes inside the fuse cartridge where the heating element terminals engage with terminals on the side of the cartridge and the fuse link is connected to the fuse terminals at the ends of the cartridge. The terminals of the heating element are connected to the fuse terminals of the adjacent fuse so that the heating element is in parallel with the adjacent fuse. When the adjacent fuse is blown the open phase voltage across the blown fuse is impressed on the heat element of the first fuse. The heat element melts the fuse and then melts itself, thus making two breaks in the cir-



cuit and shutting down the motor. Likewise the remaining fuse is blown, if the motor is three-phase.

Safety Switches.—The Square D Company of Detroit, Mich., has recently brought out a safety switch known as the 80,000 series, in which several new features are incorporated. The switch has unit bases of moulded composition for each jaw and fuse clip, instead of the old slate base. The maker claims that this does away with base breakage and metallic veins and also permits removal of parts from the front of the switch in a few minutes' time. The manufacturer also states that the Square D cover control makes it impossible to open the box cover while the switch is closed and prevents operation of the switch when the cover is open. A key permits authorized persons to do both these things, allowing for competent inspection under load.

The Super-Safety Switch Company of Chicago, Ill., reports that it is increasing its line of switches to include sizes up to 200 amp., 600 volts. Until the present time the "Super-Safety" switch has been built only in the 30-amp. size.

The Mutual Electric & Machine Company, Detroit, Mich., has made some recent large installations of its model WF-5, dead front, industrial-type switchboards. On these switchboards the operating levers are mounted on the front of the board and means are provided for locking them on or off with ordinary padlocks. The switches with connecting busbars are mounted on the rear of the board, ample wiring room being provided between the switches and the board. All parts are removable units which permit of repairs or replacements without interfering with other apparatus on the switchboard. Fuses and parts holding the fuses are disconnected and "dead" when the switch is open.

The Westinghouse Electric & Mfg. Company has developed an enclosed-type safety switch in which special provisions have been made for extinguishing the arc. It is pointed out that this feature has been found to be very effective both on direct current and alternating current. A new safety motor starting switch that also has the arc extinguishing feature is made by Trumbull Electric Mfg. Company, Plainville, Conn. The maker points out that this switch has protection against single-phase operation of the motor.

The Miniature Breaker Company, Inc., of Long Island City, N. Y., has recently developed a line of "Minibreakers" that are a circuit breaker and motor starter combined and are for use on small polyphase motors the full load current of which is 20 amp. or less. The maker claims that the "Minibreaker" gives very small motors protection against overloads and single phasing which cannot be readily obtained from fuses.

The Trico Fuse Mfg. Company of Milwaukee, Wis., calls attention to the economies that can be obtained through the use of Trico fuses because it is impossible to double up the renewal links, thus permitting overloads to the circuit and also damage to the fuse through overloading.

Substation Equipment

The Westinghouse Electric & Mfg. Company has made interesting improvements and developments in substation equipment among which are the following: the addition of high reluctance poles to 60-cycle synchronous converters; improvement in design and reliability of static condensers; use of the "Inertaire" transformer, in which an inert gas is introduced above the oil level to protect the oil against oxidation and reduce fire and oil explosion risks; improvement of the manner of making transformer tap changes; the development of supervisory control or machine switching, by which a single operator in a central location may have complete control information concerning the operating status of an entire generating and distribution system.

The General Electric Company reports the development of a new induction voltage regulator.

Both companies report an increased use of truck type switches and the rapid extension of automatic substations to coal mining and industrial fields.

Meters and Relays.—The Esterline-Angus Company, Indianapolis, Ind., has brought out a new line of graphic instruments known as type LR. The maker points out the following new features of these meters: A removable ink well to facilitate filling and cleaning; a pen element that can be removed quickly without the aid of tools; the entire back of the case can easily be removed without breaking any electrical connections.

The meters can be furnished with either spring-operated or electrically-operated clocks. The electrically-operated clocks are made to operate in connection with standard, impulse-type timekeeping systems. Where a number of instruments are installed, a master contact-making clock can be used to control all of the instruments, and where an electrical time system is already installed, the instruments can be connected to this system. In this type of clock the escapement and springs driving it are omitted and replaced by an electromagnet, actuated by impulses of current from the controlling system, which drives the chart moving mechanism.

The Esterline-Angus Company states that the national Bureau of Standards has recently made some interesting tests on the Esterline-Angus portable universal transformer which has six primary combinations giving a range from 0 to 800 amp. This company has also developed a wind velocity meter which measures the instantaneous velocity in miles per hour. The meter is made in the indicating or recording types and finds application on coal or ore bridges where it is desirable to know the velocity of the wind so that operations may be stopped and the bridge clamped to the rails when the wind velocity becomes dangerously high.

During 1923 the Weston Electrical Instrument Company., Newark, N. J., placed on the market a group of portable a.c. testing instruments which are known as the Weston Junior group. They consist of shielded movements enclosed in bakelite cases. This group has, in addition to its unusual portability, the very advantageous feature that it is possible, by means of two portable transformers, the model 461 current transformer and model 457 potential transformer, to obtain readings covering a range from practically 0 to 2,200 volts and 800 amp.

The Westinghouse Electric & Mfg. Company has developed an entirely new line of a.c. switchboard instruments working on the dynamometer principle and replacing the former

well-known Westinghouse induction type. These new instruments contain many novel and interesting features. In addition to the usual 7-in. type, these are made as a complete line in a smaller case 4⅜ in. in diameter, in agreement with the engineering tendency to recommend smaller instruments than formerly, with more compact switchboard and control board designs. The manufacturer points out that these new lines will hasten the time when the switchboards for the largest power plants will be miniatures of the types heretofore used. These new a.c. instruments are on the same basis of design and application as the recently announced d.c. instruments which they match in appearance, thus forming a complete and harmonious line of instruments of both a.c. and d.c. types.

The Cutter Company, of Philadelphia, Pa., is now manufacturing as a separate device which may be fitted to any rotary control, the I-T-E "Synchronism Actuated Lock-Out Feature." This is for use in connection with starting and running switches for synchronous converters to the end that the switch may be passed into the running position only when the rotary which it controls is in approximate synchronism with the system to which it is to be connected.

The General Electric Company has developed a new type of induction overload relay which has a target that is built in the relay and indicates when the relay has functioned to trip the particular circuit which it controls. The contacts are definitely geared to the shaft. The holding coil of these relays, therefore, does double duty in that it holds the contacts closed after they have once been closed in any cycle of operation and also operates the target. This relay can also be provided with undervoltage protection.

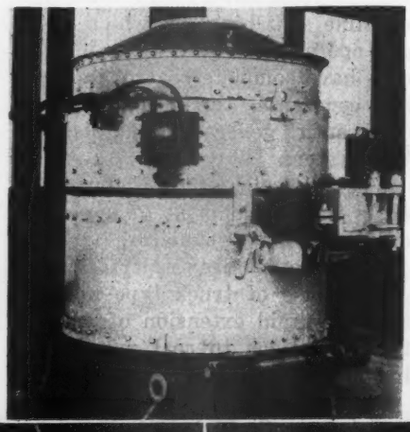
The Westinghouse Electric & Mfg. Company has built an operation indicator which shows which relays have operated during a system disturbance and aids in adjusting the operation of the relays by locating the cause of the disturbance and fixing the responsibility for it.

James G. Biddle, Philadelphia, Pa., has brought out two new insulation testers known as the "Meg" and "Super-Meg." These two new instruments are an addition to his line of "Megger" testing sets and the maker points out that they meet a definite need for portable, insulation-testing instruments at a lower cost than heretofore.

Industrial Heating

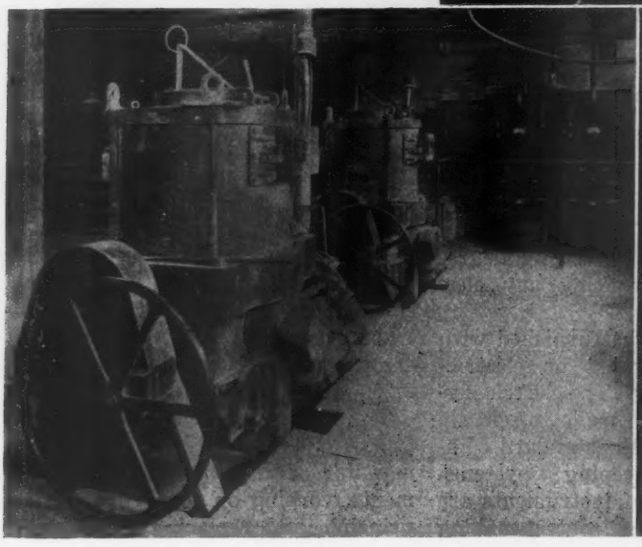
Heating Units.—The Edwin L. Wiegand Company, Pittsburgh, Pa., has placed on the market Chromalox strip heaters which can be secured in varying lengths from 12 in. to 6 ft. with wattage and voltage as required. The heating element in these heaters is nickel-chromium ribbon, which is embedded edgewise in a refractory material under hydraulic pressure of 100 tons. The embedded heating element is entirely enclosed in a rust-resisting iron, or Monel metal, and the embedded terminals are of patented construction joined direct to the resistor without the use of screws or brazing. The manufacturer states that these heating elements have been designed to withstand wide variation in voltage and temperatures up to 1,400 deg. F. without danger of injuring the element or terminals. Their construction prevents oxidation or external misuse damaging the heating element.

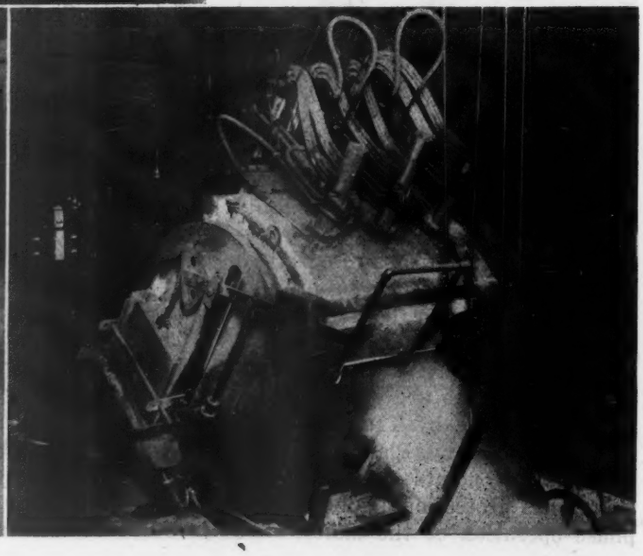
The Cutler-Hammer Company, of Milwaukee, Wis., reports that new and unusual applications are constantly being made of the C-H space heater. Recent unusual applications are in gum drying ovens, film drying



Repulsion-induction furnace made by General Electric Company of Schenectady, New York.

The force of magnetic repulsion existing between transformer primary and secondary windings is utilized to cause a circulation of molten metal between the heating circuit and the melting pot.





Resistance-type furnace made by Baily Furnace Company of Alliance, Ohio.

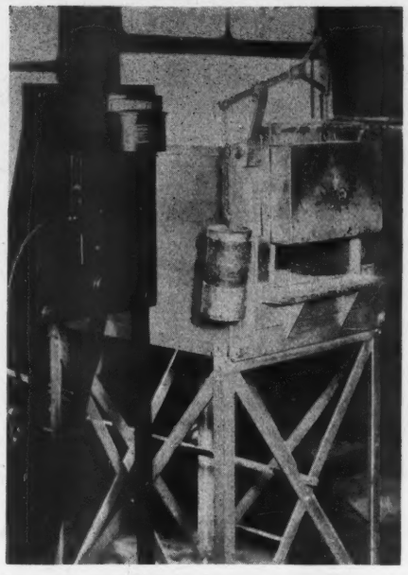
This furnace has a new radiant dome that eliminates the usual trough supports. The lower picture shows a tilting furnace made by Green Electric Furnace Company of Seattle, Wash.

ovens and in investigating the tensile properties of cotton yarn.

Extended use has also been made of space heaters made by the Russell Electric Company, Chicago, Ill. Each is an independent 500-watt heater with 22.75 in. mounting centers so that as many as required can be easily installed.

The Wireless Resistor Company of America, at Milwaukee, Wis., has put on the market a new non-metallic resistance element known by the trade name of "Globar." The material constituting the element is, in part, silicon carbide and somewhat resembles the compound which is known commercially as carborundum. The material is moulded into round bar shapes and is mechanically strong and rigid regardless of the temperature applied. The manufacturer states that "Globar" may be operated at temperatures up to 2,400 deg. F.

A very interesting industrial application of electric heating has been made by Freyn, Brassert & Company, Chicago, Ill. The application is a heater for preheating the finishing rolls of sheet and tin mills. The advantages claimed for electric preheating, compared to previous methods, are that the heat may be more evenly applied to the rolls and that more accurate control of the amount of heat applied is obtained. This results in reducing roll breakage and increasing production due to the fact that the rolls can be brought nearly to normal operating temperatures and shape. The maker reports that so far this has not been obtained by any other method of preheating. The heat is applied to the roll by means of special strip heaters assembled on a framework that fits them closely around the rolls. The framework is designed so that it may be quickly clamped or released from the rolls; consequently little time is lost when making the change. An installation is shown on page 69 of this issue.



Electrically-heated furnace for heat-treating steel made by Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa.

The temperature is maintained automatically by means of the control relays shown at the left of the furnace.

Electrically-heated solder pots of 750-lb. capacity made by Westinghouse Electric & Mfg. Company of East Pittsburgh, Pa.

Automatic temperature regulation is maintained on these solder pots by means of the control panels shown in front of the pots.

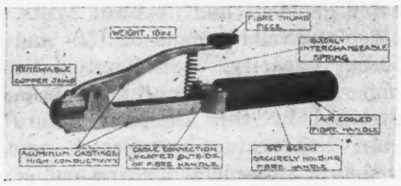
The Westinghouse Electric & Mfg. Company reports that electric heating is continuing to find favor in the industrial world for certain applications, one of which is electrically-heated solder and babbitt pots. Solder and babbitt pots of 150- and 750-lb. capacity, with automatic temperature regulation, have been developed by this company. Here again temperature regulation applied to a soft metal melting pot of this character is a distinct step forward in the industry.

Electric Furnaces.—The Bailey Furnace Company of Alliance, Ohio, has recently developed a new radiant dome electric furnace for melting brass and nickel alloys. The maker points out that this furnace embodies some radical features as it completely eliminates the usual trough supports formerly required by resistance-type furnaces, the resistor ring being entirely self-contained in a separate middle section. It has the advantages of heating up more rapidly than other furnaces of this type and a much higher melting capacity than was formerly thought possible in a resistance-type furnace.

The Green Electric Furnace Company, Seattle, Wash., has made an effort to standardize its electric steel and iron melting furnaces so that they will operate on the standard 220-volt, three-phase power circuits. The maker states that the necessary range of voltage between electrodes is provided by means of a voltage regulator which is really an autotransformer taking current at 220 volts, three-phase, and supplying current at any voltage required between 90 and 140 volts. The manufacturer reports that he has further improved the furnaces so as to make them operate with a very low power demand; hence, when it is desired to melt slowly the power may be used in such a manner as to create a high load factor and therefore a low cost per kilowatt-hour.

The General Electric Company has developed and made installations of a new type of induction furnace, which utilizes the force of electromagnetic repulsion existing between transformer and primary and secondary windings, to cause a circulation of molten metal between the heating circuit and the melting pot. The maker reports that a notable accomplishment of the repulsion-induction furnace was the successful melting of pure copper on a commercial basis.

The Westinghouse Electric & Mfg. Company states that its arc-furnace automatic regulator has been brought to a higher degree of perfection than ever before and is now being widely used.



New welding electrode holder made by Gibb Instrument Company of Bay City, Michigan.

The Electric Furnace Construction Company of Philadelphia, Pa., is introducing Soderberg electrodes —an electrode developed in Europe and for which the maker reports a lower first cost, reduced consumption, and continuous furnace operation, no time being lost for changing electrodes. The Soderberg electrode is a continuous electrode, made, baked, and consumed in the same furnace. A raw mix of carbonaceous material is tamped into a ribbed cylinder of light gage metal, thus forming the electrode. The baking process is accomplished by the waste heat from the furnace. As the electrode is consumed, it is lowered into the furnace and new sections of casing are added at the top as required.

Electric Welding. — The Allan Manufacturing & Welding Company, of Buffalo, N. Y., has developed a polyphase arc welder. The maker states that this welder is a specially-constructed transformer which is fed from a polyphase, a.c. power line and transforms the current to the proper voltage and amperage required for successful arc welding. The welder is constructed to suit any alternating-current primary power supply as to voltage and frequency.

The Liteweld Company, of Cleveland, Ohio, has developed a portable, arc-welding generator with a "divided pole" construction which, it is claimed, reduces from 40 to 50 per cent the active material required in a machine of a given capacity. The maker points out that this results in a smaller machine without loss of power, efficiency or reliability.

The Gibb Instrument Company, Bay City, Mich., has put on the market a new welding electrode holder. The maker points out that it is made of cast aluminum and weighs only 15 oz., that it has renewable copper jaws, and that the holder remains cool because of the high conductivity of the aluminum members, of a special, air-ventilated handle, and because of its outside cable connection.

Repair Shop Tools and Supplies

Winding Machines.—The Mutual Foundry & Machine Company, Atlanta, Ga., has recently developed a combination reel rack and tension device, which is designed for handling a maximum of nine 24-in. reels. The tension device has slots for nine wires and is so arranged that individual tension may be applied to each wire, thus insuring uniform tension on a multiple-wire coil.

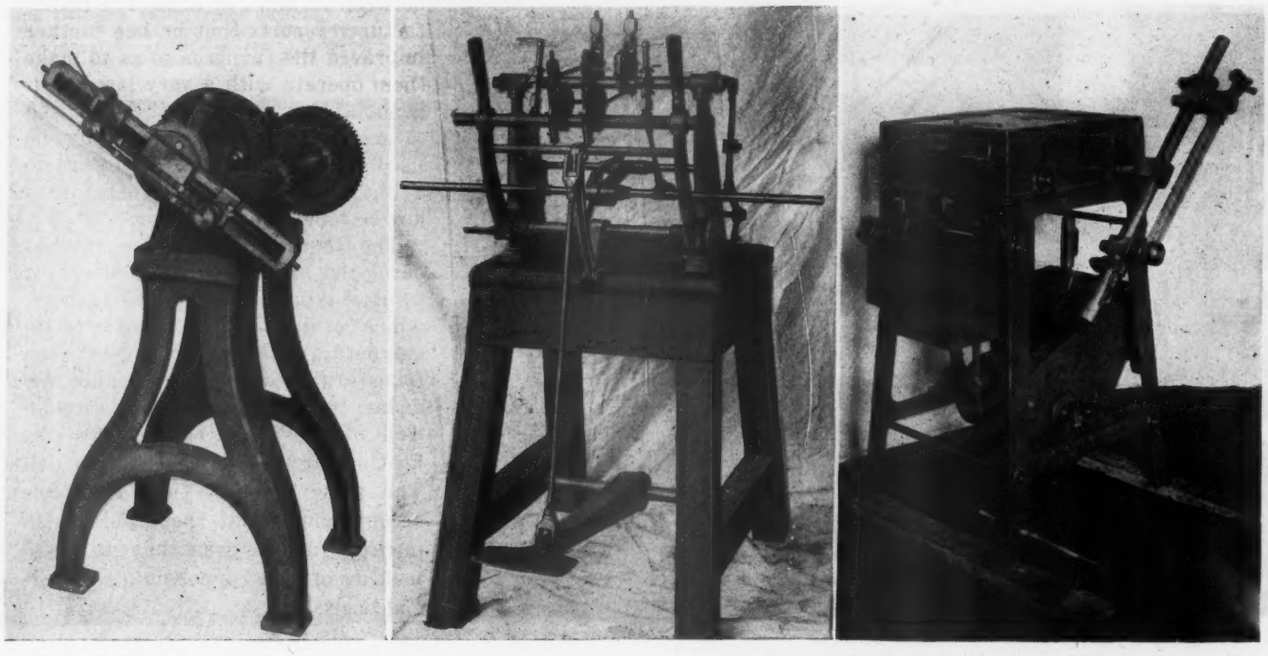
Some recently developed coil winding machines that will save money in the armature repair shop.

The left-hand machine is a high-speed "pin-coil" winder made by W. P. Hunsdorf & Company of Cleveland, Ohio. The center device is a coil duplicating machine made by the same company. The machine, which is illustrated below on the right, is a coil winder equipped with a self-contained motor. This winder is made by the Mutual Foundry & Machine Company at Atlanta, Georgia.

This company has added a self-contained motor sub-base carrying a 1-hp., 1,750-r.p.m. motor, to its Browning coil winder.

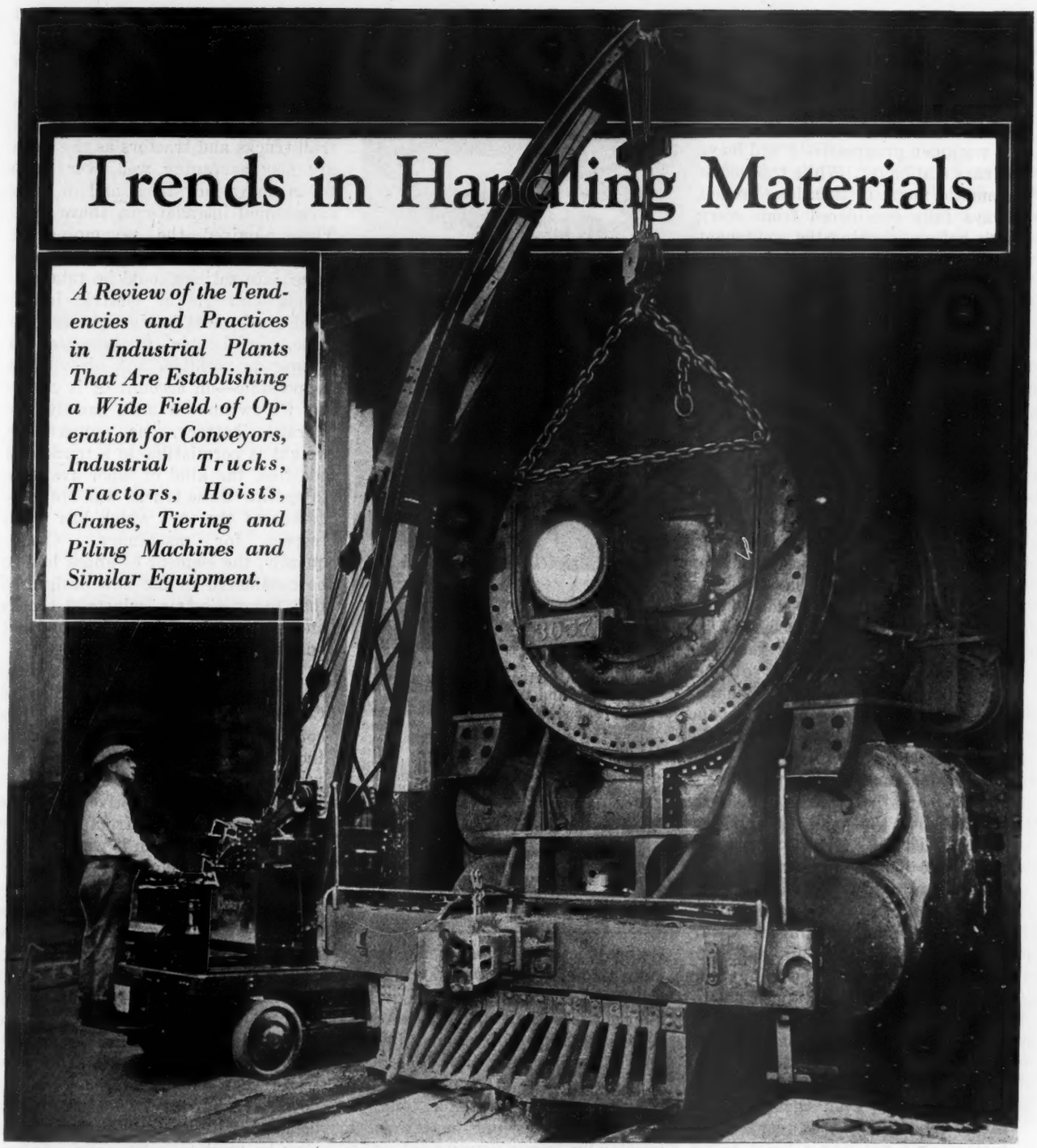
W. P. Hunsdorf & Company, of Cleveland, Ohio, has developed a high-speed "pin-coil" winder for which the advantages of quick adjustment, easy operation, and a pin spacing which remains as set, are claimed. This company has also developed a new coil-duplicating machine.

The B. T. Coil Former & Tool Company, of New York, N. Y., has developed a new combination coil winding and spreading machine. The maker points out that this machine produces a rigid coil that rarely requires varnish to hold it for taping. (*Continued on page 104*)



Trends in Handling Materials

A Review of the Tendencies and Practices in Industrial Plants That Are Establishing a Wide Field of Operation for Conveyors, Industrial Trucks, Tractors, Hoists, Cranes, Tiering and Piling Machines and Similar Equipment.



Using a 19-ft. boom industrial crane truck in assembling the front smoke box cover of a locomotive.

By FRANK E. GOODING

Associate Editor, Industrial Engineer

UTILIZATION of material-handling equipment in industrial plants in place of man-power has been undergoing a gradual growth for years. When Ford introduced conveyors in the processing and assembly of automobiles, although this was not the first such application, the possibilities were perhaps more forcibly broadcast than ever before to the attention of the industrial public. Other automobile companies quickly followed this lead until the automotive industry has, more than any other, developed material handling to suit its own needs. Conveyors, as in the early days of the industry, still form the nucleus of material-handling and assembly systems, but the modern automobile plants now take advantage of industrial trucks—both hand and electric—tractors, hoists, trolleys, cranes, and other types of material-handling equipment.

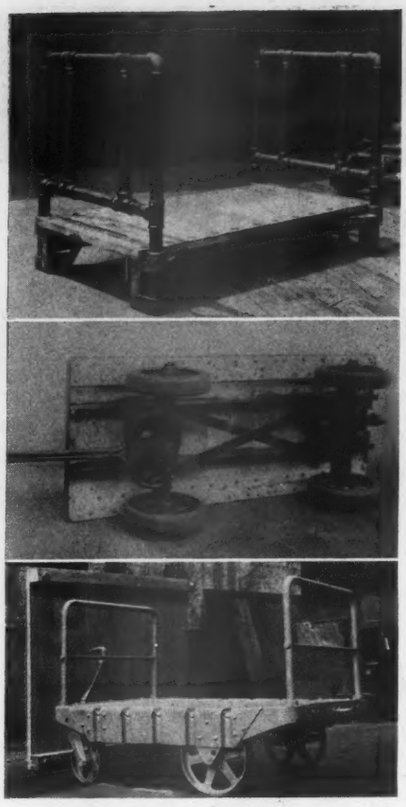
Developments through recent years have emphasized the need of special study in the applications of equipment to special work. This requires a consideration of the product and quantity handled. What might be best for one plant might not be suitable for another, even though producing a similar product. An extreme example may

be taken from the automotive industry. Here the large plants could not get along without conveyor assembly; in contrast a small plant, producing only a few cars a day, would find it much more expedient to move the workmen progressively and leave the cars stationary. While this seems axiomatic, many installations are not always fully considered from every angle before selecting the equipment for the job. Sometimes conveyors are used when industrial trucks or trolleys would be more satisfactory. The contrary is also true. Users are, however, obtaining a better knowledge of the problems involved and the methods of solution so that they can more judiciously apply this knowledge to the selection of the most effective equipment.

During the war and in the prosperous period which followed, labor learned to shun work which required heavy lifting and carrying. Immigration restrictions together with the change in the class of those immigrants received prevented the replenishing with a new class of labor to do this work. This naturally called for the substitution of mechanical means for muscle in handling heavy units and has been one of the principal reasons for the wider demand for material-handling equipment during the past year. This demand has been particularly noticeable in the hand-lift and electric industrial truck fields—two classes of tools which have a wide application in all industrial lines and can also be used to decrease the cost of miscellaneous handling of a varied line of material in its many movements through the shop from its receipt until it is shipped out.

Almost any shop which handles even a comparatively small quantity of material will find that it can use either a hand or electric lift truck advantageously even though it has little opportunity for other such tools except possibly a hoist or piling machine. Many large plants find that these machines often work into the material-handling scheme for the miscellaneous work which does not travel over the fixed path to which a conveyor or hoist is limited.

In general, the developments for 1923 in the industrial truck field have been toward the production of heavier equipment by the concerns who have had the most extensive experience. There was a similar development during 1922, but this tendency was more marked last year.



A skid or platform for an elevating truck and two trailers.

The pipe ends may be removed so that this Cowan platform may be used alone. A similar type with higher legs is made for an electric truck. The middle view shows the construction of a Cowan trailer and the way it is connected up to track. This all-steel Elwell-Parker trailer (below) weighs 600 lb. and is capable of carrying a load of 6,000 lb., either as a trailer or to be carried on a heavy-duty industrial lift platform truck. For hard, severe service many users are turning to steel platform and tote boxes; such as the Truscon. Steel platforms and boxes are necessary if hot forgings or similar material is to be transported.

Before the war it was seldom that more than 3,000 lb. was carried as a truck load, with the average load running less than 2,000 lb. As users of this type of equipment became more familiar with these tools, they were prompted to apply them to more specific work, so that today we find them handling materials in practically every department of an industrial plant and operating not only on floors, as originally intended, but in unpaved yards, up inclines, through tunnels, across bridges, and in fact, anywhere that one could possibly handle a load on a hand truck.

Numerous types of accessories have been applied to these equipments in order to especially adapt them for the job in hand. The requirements of some of the applications naturally have exceeded the strength of the original designs and have often revealed weaknesses. Sufficient demand for these special tools has naturally resulted in the standardization of improvements to overcome these weaknesses.

These conditions have resulted in the demand for larger electric industrial trucks and tractors as the loads are now averaging well over 4,000 lb. in many industries, and in some exceptional installations, above that. This required the revamping of many types in order that the same nameplate ratings could be retained. Fundamentally, the electric industrial truck must be as light as possible, as flexible as possible, as strong as possible, and as efficient as possible—on account of it carrying its own power unit, namely, the storage battery, no superfluous weight is permissible in a truck. In addition, the kind of labor available to operate these trucks was not altogether of the sort which has much respect for machinery. Consequently, the element of abuse had to be considered in the new design, so that today electric industrial trucks and tractors have been designed not only for use but against abuse.

The rating of "tructors" (a term which The Elwell-Parker Electric Company, Cleveland, Ohio, has coined as descriptive of the electric industrial truck or tractor and advocates its general use by all manufacturers as descriptive of this equipment) today is from 50 to 100 per cent greater than it was in 1913. However, the weight of the equipment has been increased on an average of only 33 to 66 per cent when in some special cases, such as crane trucks, capacities have increased in a ratio of 6 to 1, or 500 per cent with an increase in weight of only 3½ to 1, or 250 per cent. In line with these demands of industry, two or three manufacturers of electric trucks have produced a special power crane truck with a 12-ft. boom for lifting and piling. This may be used to enter railroad cars, to load or unload, to set or remove dies, to place or remove heavy parts on machine tools, for piling or unpiling castings or other heavy stock, and other heavy lifting or handling and moving.

If the distance to be traveled is short, as from the inside of a car to a truck or nearby storeroom, this crane tructor is generally used to do both the lifting and carrying. If the distance is considerable, however, it is more economical to deposit the load on another truck or

One man could not pick these up alone without a crane such as this.

Crane trucks, like this and others shown on the accompanying pages, enable one man to pick up heavy pieces of material almost anywhere in the yard and deliver them in any of the shops. This Crescent truck has a capacity of 1,500 lb. and is of the high-wheeled type.

trailer for the long haul. However, for much of the miscellaneous handling of heavy material about a yard or plant, the crane tructor not only picks up but also carries its load to its destination. In several installations magnets are used on the crane to handle pig iron and scrap, either in yard storage or to load or unload gondolas or the industrial trucks or trailers which are used to carry the iron to the cupola.

These crane trucks have a lifting capacity of about 3,000 lb. at a radius of approximately 6 ft., and 1,000 lb. at a radius of 12 ft. A special 19-ft. boom is sometimes added when the crane is used on high work, such as in locomotive repair shops for fitting or removing smokestacks. This can also be used for fitting or removing other heavy parts such as pumps, smoke box fronts, springs, wheels and axles, pistons, crossheads, and other heavy parts which are not so high and could be reached by a truck with shorter boom.

Another tructor development has been along the line of a high-lifting elevating platform truck which will lift from a low height of about 12 in. to a top height of about 60 in. These are called "Hi-Lo" tructors, or tiering or piling trucks. They are commonly used to pile material, to place or remove dies, to load box cars or motor trucks, and to handle material on platforms which must be raised more than the ordinary elevating platform is capable of doing. With the "Hi-Lo" the skids or platforms, with load, may be stacked. One plant, with material which cannot be piled very high, even uses these "Hi-Lo" tructors to elevate loaded platforms so that they may be suspended from the ceiling and in this way get the full storage capacity of the room. Most of these tructors have a capacity of 5,000 lb. and serve as an all-round, general utility truck. Neither this nor the crane truck, however, is expected to be used where sufficient straight hauling is on hand to keep an elevating platform or tractor and trailers busy. Several adaptations of this high-lift elevating platform tructor have been made for special work. The use of one of these for handling tin plates is shown in an accompanying illustration.

The recent developments of the various larger manufacturers of tructor equipment have not been entirely uniform because in some cases developments have been made previous to this year, while other manufacturers took the opportunity to complete practically a full line of electric industrial trucks and tractors for all the various industrial applications.

In the endeavor to complete his line of trucks, one manufacturer has added a chisel-platform, electric lift-truck in which the chisel teeth project forward from the truck almost level with the floor and slip under the load and elevate it. With this one man can pick up almost any load and deliver to its destination alone. The application of this was discussed in an item in the INDUSTRIAL ENGINEER, on page 561 of the November, 1923, issue. Another company has developed a special, low-platform, general utility truck which may be provided with a boom crane, a demountable dump body or used for general all-purpose hauling. Another manufacturer has produced an attachment which is placed on a low-platform electric truck and makes it a hand-operated, elevating-platform truck.

Recently a few manufacturers have begun the development of a line

An example of a yard application of a long-boom industrial crane truck.

This truck can run alongside a row of these cable reels and lift any one from the group. During the past year many long-boom trucks have been installed in railroad shops for fitting and repair work around the locomotives. This Elwell-Parker truck has many other industrial applications, such as piling or unpiling, setting dies, assembly work, and many other miscellaneous tasks which would be light for a large locomotive crane.

Tractors and Trailers for Industrial Hauling

Eleven Examples of What This Equipment Will Do

A—New three-wheel type of Yale tractor with train of six-wheel trailers.

B—Baker R & L crane truck with load of thin sheets.

C—Handling a load of 5,500 yards of cotton goods with a Lewis-Shepard hand-lift truck.

D—This three-wheel gasoline Clark tructractor will crane 2,000 lb. or tow one to twenty trailers.

E—Loading cars with a Yale high-lift elevating platform truck.

F—Using a Cowan electric truck as a tractor and trailing Cowan hand-lift trucks.

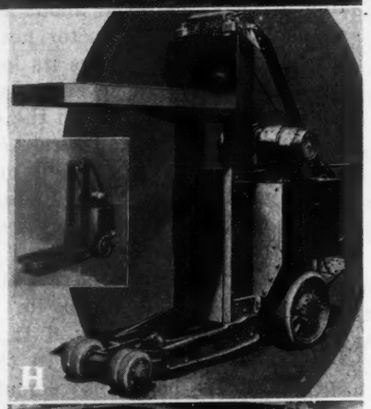
G—A new type of Mercury three-wheel, internal-gear tractor with trailers.

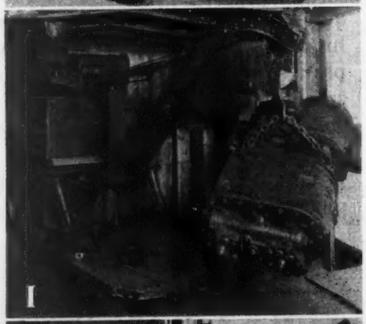
H—Elwell-Parker "Hi-Lo" truck with platform at top and bottom of its travel.

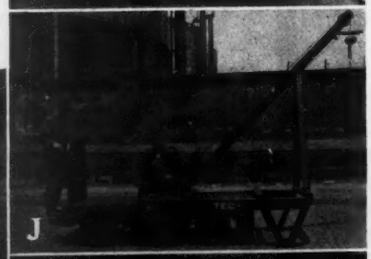
I—Depositing 1,800 lb. air receiver in box car by aid of Elwell-Parker crane truck.

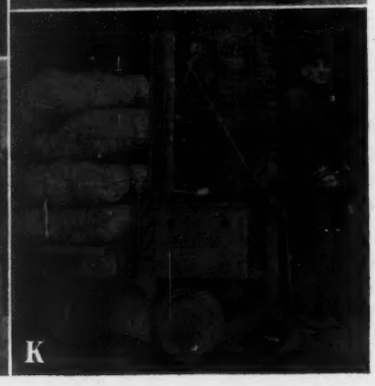
J—This crane attachment is built on a separate lift-truck platform for a Terminal Engineering truck.

K—One of the miscellaneous handling jobs of a high-lift Elevayor truck.









of light-duty electric elevating- and stationary-platform electric trucks with the idea that there was sufficient demand for a standardized truck of this sort. Similarly, one producer of high-wheeled electric tructors which are particularly adapted for use on yards and over rough floors and passageways has added a crane truck to his line of equipment. Another manufacturer of similar equipment has provided a special skid with a crane attachment which may be lifted by the elevating mechanism of the truck as is any other platform. The crane motor receives its power from the battery and in this way the regular truck may quickly become a crane truck. The crane platform may be as quickly set to one side and the truck again used for regular work.

Practically each manufacturer of electric and hand truck equipment nas produced a special, steel-reinforced skid or platform which is shipped knocked-down to the user. Originally, most platforms were made of wooden planks by the user according to his own ideas. Many of these were improperly designed and would not stand up under service. Manufacturers now realize the importance of good skids or platforms to assure the reliability of service of which a tractor or hand-lift truck is capable.

Considerably increased demand has been shown for steel platforms, particularly with the addition of a box to hold material, especially around foundries and shops engaged in metal manufacturing where the abrasion of the parts would soon wear out a wooden tote box. While these originally were designed for use in handling hot forgings, their lasting qualities have brought them into much wider use. Four-wheeled trucks and trailers are also made with steel platforms, as shown in the accompanying illustrations. In this case the truck is made so that it can be used as a trailer, can be lifted by an elevating platform truck and carried, and is also arranged so that it can be lifted by an overhead traveling crane. This flexibility of units adds much to the value of material-handling installations.

One type of platform is made to use on either a hand or electric lift truck; the hand-lift truck lifts the platform endwise and the power truck crosswise. Manufacturers of hand trucks, live-platforms and trailers are using ball-bearing casters more commonly. One manufacturer of casters has produced a double-ball-race caster for this purpose.

Recent Developments in Other Material-Handling Equipment

Developments in the hand-lift truck field recently have also been towards the providing of equipment which would handle heavier loads. At present, hand-lift trucks which will handle up to 15,000 lb. may be obtained. One company has developed the trailing of loaded hand-lift trucks behind tractors or other electric trucks, as shown in an accompanying illustration.

Two or three manufacturers have added three-wheeled tractors to the line of tractors and industrial trucks which they were already manufacturing. One well-established company has added an internal-gear-drive tractor to its line, making it a producer of both worm- and internal-gear-driven tractors. The manufacturer claims considerable increase in efficiency of this tractor by using the internal gear. A manufacturer of a gas-driven tractor has added a special crane for loading trailers or general utility purposes, as shown in an accompanying illustration.

During the past year or two several companies have brought out new designs of piling or tiering machines. One, for example, has been of a light capacity—up to 500 lb. This is made in both hand and electric types. The electric type, it is claimed, can receive its power from a lamp socket. Larger units require a power circuit.

Another company which manufactures a wide line of tiering machines from small capacity up into large units has developed a special telescoping frame, whereby the equipment is able to operate anywhere from about 6½ ft. up to full height of the telescopic attachment. This machine can pile under a sloping roof, under or on top of a balcony, around beams, or other obstructions overhead and in similar places where a tiering machine of fixed height could not operate. With this machine the frame is made in two parts, one telescoping within the other. In the telescoping-frame tiering machine the platform is fastened to the telescoping part and is elevated first to the top of this section. When it reaches the limit the telescoping frame is then raised, so that the load is always at the top of the telescoping frame. Several four-poster tiering machines with large platforms, in some cases large enough to handle automobiles, have also been developed. In addition, many users of piling machines who have purchased hand-operated equipment are adapting them to electric drive by the addition of a motor.

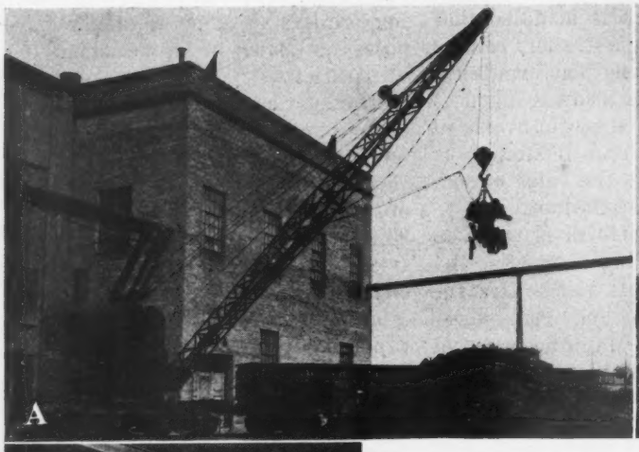
Probably but few plants handle so little heavy material that they do not have an opportunity to use a hoist or crane to advantage. This type of equipment is occupying an ever-increasing place in industrial material-handling applications. Men dislike heavy lifting, as was mentioned. It is also slow work and

This is a standard type of electric truck modified for special work.

A Yale high-lift, elevating-platform truck has the platform and the wheel base shortened, and fingers, together with clamps, are provided for handling tin sheets. Instead of using skids, as is required in other work, the piles are separated by small pieces of plank just high enough to enable the fingers to slip in between the layers.

Types of Equipment for Handling Materials

Some of These May Be Used in Almost Any Plant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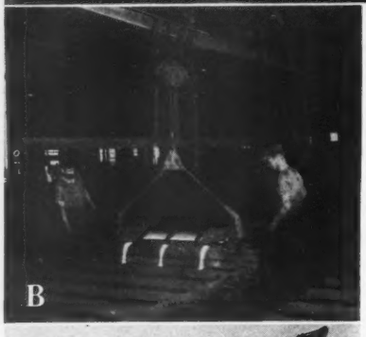
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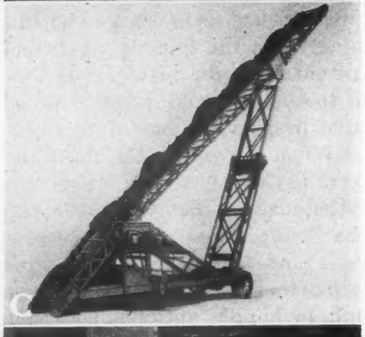
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A—Handling pig iron with an Industrial Works locomotive crane and magnet.

B—Pouring cast-iron pipe from a three-lip flask carried by a Motorbloc hoist.

C—This electrically operated Jeffrey stacker with telescoping arm for raising and lowering will handle about 500 bags per hr.

D—Old type of Standard disk roller conveyor handling shingles. The manufacturer is again introducing this type of construction.

E—Economical storing and reclaiming of coal with a Godfrey conveyor and clamshell bucket.

F—Driving mechanism and Jeffrey conveyors for handling automobile bodies.

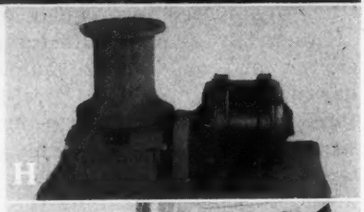
G—Unloading and piling pig iron with a Shepard hoist and magnet.

H—Silent Hoist capstan and car puller operated by an electric motor.

I—Gasoline operated Standard portable belt conveyor for handling coal and other loose material. Electric motor may be attached if desired.

J—A Jeffrey portable belt conveyor which is made either to suspend from slings, as shown, or to be carried on wheels for yard work.

K—This Jeffrey lift or tray elevator carries the automobile bodies from one floor to the next.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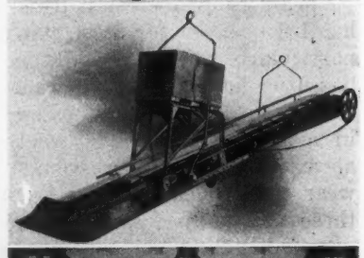
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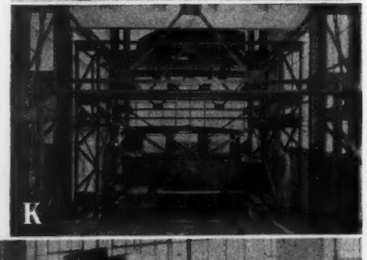
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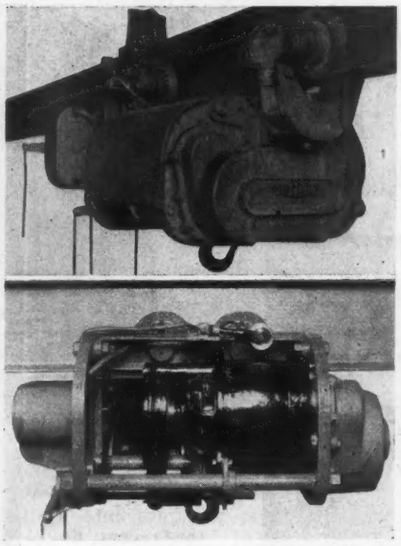
often requires a helper. It does not pay to keep a machine idle long while waiting for a helper or while waiting to place or remove a heavy piece on a machine tool. If a hoist or crane is provided for that tool, it is always on hand and in many cases will soon repay its cost through the increased production or decreased wage expense of a helper.

An interesting example in one industrial plant indicates the trend in hoist applications. In this case a hoist served one of a group of machines. This machine was the bottle-neck in the line of production, and choked up a process wherein the work flowed through several machines. The slow-speed hoist feeding this machine was supplanted by one of a faster type. Also, it was provided with special devices for quickly gripping and releasing the work. This speeded up this machine enough to enable it to keep up with the capacity of the others in the group. This does not mean, however, that the field for slow-speed hoists is decreasing, as there are many places in which they still operate as fast as is necessary. A study of quick-gripping devices adapted to the service requirements of a hoist shows that these still offer considerable opportunity for development.

Recently at least two companies have produced an electric hoist which will operate with very low headroom. These are particularly advantageous in the older constructed shops where the ceiling is low. The other hoist, which is really a chain block with an electric motor attached, is finding considerable application in fields where the hoist must be moved frequently, as on maintenance work and other places where it is used temporarily, because it is of a lighter weight than the standard electric type of hoist. Another manufacturer of a wide line of electric hoists has standardized on hoists of 500 to 2,000 lb. capacity with worm drive instead of internal gears.



Two views of the "Lo-Hed" monorail electric hoist.

This is an end view and a side view of a 3,000 lb. American "Lo-Hed" monorail electric hoist. The side view, with cover removed, shows the accessibility and convenience as well as the arrangement which makes it possible to raise the hook so high.

There is also an increasing number of yard and shop applications of the cage-operated electric hoist on monorail and crane crossovers. One of these recent applications is pictured in one of the accompanying illustrations. These hoists will cover a wide area in any industrial works and tie together the transportation between several separate units.

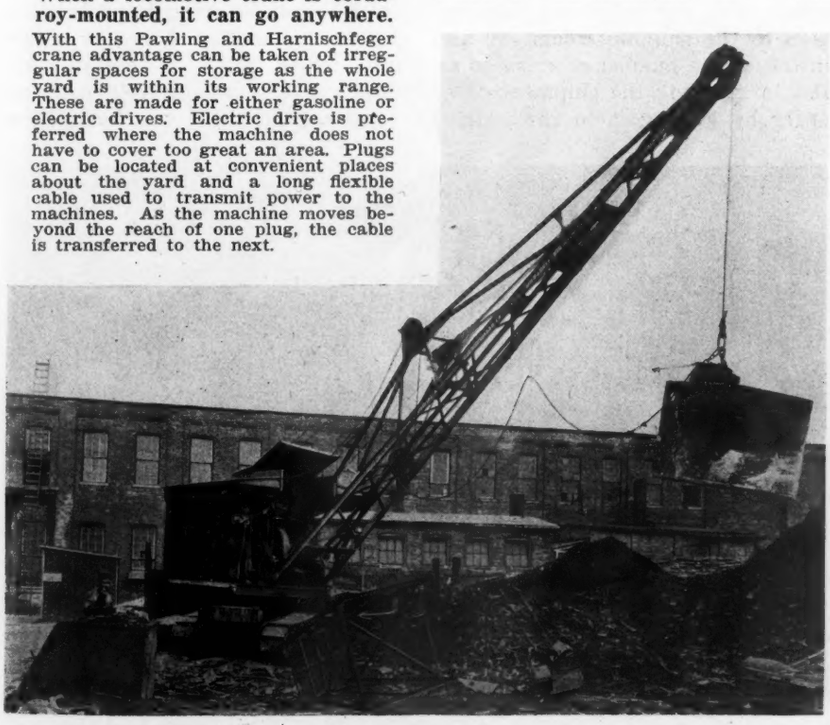
There has been considerable demand from medium and small plants for cranes, hoists, and portable conveyors, as will be explained later, for use in handling coal to and from yard storage and also around the boiler plant. Large plants which have done considerable coal storage have been fairly well provided with this equipment. The older constructed plants and smaller plants are realizing that it is costing considerably more money to handle the coal as received and are installing mechanical devices to do this. As coal handling is an intermittent process, the use of material-handling devices to supplant gangs of men has resulted in worth-while economies even where no effort is made to store more than enough for ordinary requirements.

Numerous lines of industry have noted the advantageous application of conveyors for production and assembly in the automotive industry and are now applying some of these plans to their own lines. One application of a belt conveyor for assembly of small parts is shown in an accompanying illustration. Here radio parts are inspected and assembled progressively until they are finally boxed and thrown into the center section of the belt conveyor which carries them to a cross conveyor at the distant side of the room. This cross conveyor in turn deposits the boxed radio parts in the stockroom. Here, one line of belt conveyor is serving not only two rows of assemblers but also carries away the finished parts. Notice particularly the deflectors which are used to remove the parts from the conveyor belt and deflect them to each operator.

This conveyor does away entirely with the use of containers of any sort, which it would ordinarily be necessary to use to carry the parts from one worker to the next. It also acts as a pace-maker for the entire

When a locomotive crane is corduroy-mounted, it can go anywhere.

With this Pawling and Harnischfeger crane advantage can be taken of irregular spaces for storage as the whole yard is within its working range. These are made for either gasoline or electric drives. Electric drive is preferred where the machine does not have to cover too great an area. Plugs can be located at convenient places about the yard and a long flexible cable used to transmit power to the machines. As the machine moves beyond the reach of one plug, the cable is transferred to the next.



Three recent developments in the construction of tiering or piling machines.

The four-poster Lewis-Shepard tiering machine (left) is used to handle large rolls of paper for a St. Louis newspaper. The machine above (New Jersey Foundry & Machine Co.), has a platform 6 ft. long and is used to handle plate glass mirrors between the floor and a mezzanine. The frame is of wood so as not to break the plate glass mirrors. The Economy telescoping-frame tiering machine (right) is used to pile on or under balconies, around trusses, and in other similar places where it is difficult to use a machine of fixed height. The trussed part of the framework shows the minimum frame height of this machine; the position of the bale indicates the maximum extended height. These heights can be made to fit almost any ordinary condition. Considerable recent development has been made in adopting higher speeds than has been the former practice for tiering machines.

line of assemblers. Another advantage is that work of this sort can be put on a group wage-payment plan and instead of checking the production of each individual worker, it is necessary to check only the output delivered at the end of the line, as each worker will necessarily do his or her part progressively. This simplifies the checking and recording of work done but does not interfere with varying the proportion of the pay to different operators according to the skill required, the experience, and the difficulty of the various tasks they perform.

One of the interesting developments in conveying equipment during the past year has been in applying it to special industrial applications where until recently conveyors have not been considered as possible for use. The use of conveyors in shipping rooms has been extended. The particular advantage here lies in the ease and rapidity with which the packages are removed from the packer and placed in the shipping department. Many companies are, with the aid of conveyors, now able to fill orders from their shipping room within a few hours instead of requiring days as was often necessary before. Pneumatic tubes for delivering these orders to the shipping room are also installed in a number of cases to assist in speeding the shipment of an order by getting it to the packing room almost immediately after it is entered on the books.

In many lines of work there seems to be a tendency toward using ball-bearing conveyor rolls of small diameter, as they will carry smaller pieces, and do it more smoothly, then the large roller conveyors.

One company has put out a special conveyor which consists only of a disk roller, as shown in one of the accompanying illustrations. This is fastened to an angle iron and is made in both straight and curved sections. The particular advantage of this conveyor is the ease with which it may be erected and adapted to wide or narrow boxes or other units which it is to carry. Although this is not entirely new, no conveyors of this type have been

One of the many uses of a high-lift elevating platform industrial truck.

This Baker R. & L. truck can be used to place or remove a double tier of hogsheads of tobacco either in the stockroom or when loading or unloading motor trucks. With this a motor truck can haul almost twice as much as if loaded by hand. Similarly the storeroom can pile almost twice as much material on the same floor space.

manufactured for a number of years until recently.

One use for conveyors which has become more common in the last few years is to provide long conveyor systems so that goods may be loaded on the conveyors and remain until used. In this way the conveyor section acts as warehouse storage space. One concern uses a four-floor spiral for this purpose.

An example of the extensive use to which conveyors are being put in manufacturing and assembling processes is shown by an installation of eighty-seven conveyor systems in six plants of the Fisher Body Corporation during the past year. The automobile bodies are carried through the building, painting, drying and trimming operations and on to the shipping department by conveyor. In some cases the bodies are transferred from one conveyor line to another by hand. At other places this is done automatically as, for example, by the tray elevator, as shown on page 86.

As the lubrication of a conveyor system is one of the important factors in its effective operation, one of the companies has devised a special grease gun for this purpose.

To meet the industrial demand for yard service work some concerns have added to their line locomotive cranes provided with crawler or corduroy mountings so that they are not dependent upon railroad tracks or even upon a solid roadway for locomotion. These may be operated by either gas or electricity and are arranged to use either magnets, grab buckets or crane hooks, for the variety of work which they are required to handle. An installation of this kind is shown on page 86.

To aid industrial plants in the handling of coal, ashes and other loose material around the plant, either for transferring it a short distance or elevating it on trucks or piles, one company has built a standardized, portable-belt conveyor. This may be used in series to feed others and transfer coal some distance. Ordinarily, this is placed with the loading end at the dumping place of a gondola and the coal is shoveled into the conveyor. This elevates the coal into a truck which hauls it to its destination. These conveyors are driven either by an electric motor or a gasoline engine, as desired. This was described on page 369 of the July, 1923, issue of INDUSTRIAL ENGINEER. Another heavier model of somewhat greater length has been produced during the past year by still another concern. One development has been a slatted pulley which is used at the lower end to prevent loose material from wedging in between the pulley and belt.

Although stackers or pile elevators are not new, there has been sufficient demand for an additional type being produced during the past year. This is a self-propelling unit and is constructed to deliver the bags or bales of material from about 6 ft. in height to a maximum height of 25 ft. It will handle about 500 bags per hour, and may be used for either piling or breaking down a pile. This stacker raises and lowers its boom by power and also is run backwards and forwards by its own power, supplied by a gasoline engine or an electric motor.

The developments and extensions of material-handling equipment during the past year have affected practically all lines of industrial activity. It would be astounding to count the number of times material is handled in the ordinary shop and estimate the total weight in all those handlings from the time the raw material is received until it is finally shipped out. Making these movements by hand costs money and in most cases can be done more economically by some form of mechanical equipment.

Using a belt conveyor to assemble radio parts.

Each worker does his or her task on a radio part and throws it back on to the conveyor. A special arm slides it off at the next worker who performs the next task and again throws it on the conveyor and so on down the line. When finished, inspected and boxed it is thrown into the center section which carries the box to a cross conveyor at the far side of the room. This carries the box to the storeroom.

EDITOR'S NOTE: Special acknowledgment is made to the following companies for their assistance in furnishing information on material-handling equipment: American Engr. Co., Philadelphia, Pa.; The Automatic Transportation Co., Buffalo, N. Y.; Barber-Greene Co., Aurora, Ill.; The Baker R. & L. Co., Cleveland, Ohio; The Brown Hoisting Machinery Co., Cleveland, Ohio; Clark Tructractor Co., Buchanan, Mich.; Cleveland Crane & Engr. Co., Wickliffe, Ohio; The Crescent Truck Co., Lebanon, Pa.; Cowan Truck Co., Holyoke, Mass.; Cutler-Hammer Mfg. Co., Milwaukee, Wis.; The Dow Co., Louisville, Ky.; Economy Engr. Co., Chicago, Ill.; The Elwell-Parker Elec. Co., Cleveland, Ohio; Eleveyor Industrial Truck Corp., Brooklyn, N. Y.; Sprague Hoist Division, General Electric Co., Schenectady, N. Y.; The Godfrey Conveyor Co., Elkhart, Ind.; The Jeffrey Mfg. Co., Columbus, Ohio; Industrial Works, Bay City, Mich.; The Lamson Co., Syracuse, N. Y.; Lewis-Shepard Co., Boston, Mass.; Link-Belt Co., Chicago, Ill.; Mercury Mfg. Co., Chicago, Ill.; Motorbloc Corp., Summerdale, Philadelphia, Pa.; New Jersey Foundry & Machine, New York City; Ohio Elect. Controller Mfg. Co., Cleveland, Ohio; Pawling & Harnischeger Co., Milwaukee, Wis.; The Plimpton Lift Truck Corp., Stamford, Conn.; Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.; The Silent Hoist Co., Brooklyn, N. Y.; The Stamp Electric Hoist Co., Cleveland, Ohio; Standard Conveyor Co., North St. Paul, Minn.; Stuebing Truck Co., Cincinnati, Ohio; Terminal Engr. Co., Inc., New York City; Trucson Steel Co., Youngstown, Ohio; Whiting Corp., Harvey, Ill.; Wright-Hibbard Industrial & Elec. Truck Co., Inc., Phelps, N. Y.; The Yale & Towne Mfg. Co., Stamford, Conn.; The H. Zeering Mfg. Co., Cincinnati, Ohio.

INDUSTRIAL ENGINEER

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DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT F. E GOODING A. J. WHITCOMB

Chicago, February, 1924

A Time and Place for Good Judgment

DETAILS of an installation have recently come to our attention which show how easy it is to make a simple job a hard one.

A pump, driven by a general-purpose motor with automatic control, was installed in a room where the temperature is unusually high. Inasmuch as the controller had barely sufficient capacity for the motor under ordinary working conditions, the high operating temperature caused overheating of the controller contactors. To correct the trouble, circuit breakers were installed immediately ahead of the controller and a knife switch was provided to shunt the controller after the motor was started. The knife switch and controller were interlocked so that neither could function at the wrong time. Shortly afterwards it was found that failure to provide a no-voltage release for the circuit breaker left the motor subject to serious injury when the power came on, after interruption of service.

This case is mentioned in order to emphasize three points. First, an adequate margin of rating is essential under varying service conditions. Second, even in simple applications such as the above, a complete analysis of service conditions should be made. Third, when a makeshift is used, care must be taken to see that it does not introduce some new element which may endanger the entire application. Many a superintendent spends nights worrying about an incorrect mechanical or electrical application that could have been prevented by proper knowledge of the service conditions.

Material, Labor and Power Service

AFTER an industrial works is built and fully equipped the elements of production are three: material, labor and power service. In the past much attention has been paid, and definite figures have been compiled, to indicate the best balance of material expenditures and labor expeditures, but it is only recently that proper attention has been directed to power service as a part of capital account and operating expense. In those cases where investigations have been made, however, some interesting revisions of what heretofore seemed a good balance of material and labor expenditures have been brought about.

Power service today in plants that are converting raw materials into finished products on a satisfactory margin of profit, includes the correct combination of electrical and mechanical drives and control at machines engaged in production operations, and moving up to and taking away of materials worked on without loss of production time by the men working on these machines. It includes the providing of light suitable in intensity to the operations performed and the speed at which the operator can work without spoilages and rejections, adequate facilities for transportation of semi-finished and finished parts between departments, from departments to stock and from stock to shipping platform, the measurement of electrical energy used and the regular checking of machine production through graphic records to maintain fair loads on machines and to catch overloads before breakdowns occur. Finally it involves the inspection and maintenance of power-operated devices to prevent clogging of the continuous flow of materials in production through the electrical or mechanical failure or faulty operation of a single unit.

To this element of production: namely, power service and its maintenance, INDUSTRIAL ENGINEER is devoted. It is already a problem of large magnitude and will grow larger and more important as industrial works expand and cover larger area, as departments are added and the volume of work in any plant is increased. It calls for a practical interpretation by you practical men and your co-operation in working out the details of best practice. INDUSTRIAL ENGINEER aims to be your handbook and your code of best practice.

Pass This Issue Around the Works

MOST new equipment originates in one or both of two ways: From suggestions of users and buyers for special equipment that can be widely used, and from ideas of designers in simplifying or improving existing equipment that can be used in new ways or will make present methods less complicated. In one case the user justifies the added first cost by the economies that are possible, and in the other the maker justifies the development and production expense by the increase in gross sales that will in a reasonable time show an added profit on the lines that are produced. No manufacturer can afford to make a device for which there is a restricted use except at a very high cost to the user, and no user can afford to purchase all apparatus designed and built to meet his special requirements. Good operating and manufacturing practice, therefore, calls for a meeting of users and manufacturers on a common ground of standardization so that the most commonly used devices will be available at prices that quantity production and wide demand make possible.

The design room, laboratories and work shop of the maker are the center where creative ideas take on usable forms while the plant and processes of the user are the test rooms where the needed improvements due to natural wear and tear, avoidable carelessness

and rough treatment from handling by men unfamiliar with the theoretical or technical features of operations come to light and call for changes and improvements that make a scientific idea of practical use. A delicate watch mechanism in a glass case free from dust and vibration performs quite differently when carried in the pocket of a workman in a cement mill, for instance. In other words, the surroundings and use of an operating mechanism determine the service that can be expected of it. So it is in industrial work; the things that are new today in principle or application represent the thinking and needs of a few, perhaps, and will become permanent and widely used through the combined efforts of all who see the economies of the future that the introduction of these new ideas will bring about.

This issue of INDUSTRIAL ENGINEER is devoted to new developments of manufacturers and the details of new applications of standard types for the benefit of users who are working along specialized lines of plant production and have the accumulated knowledge of experience that will enable them to locate the facilities and thinking on the part of manufacturers who are now in a position to take up new requirements in their particular plants or apply some existing equipment that fits a need that heretofore might have been undiscovered or waiting for some phase of the new developments that are now mentioned by the manufacturer. Such an inventory of new ideas and new equipment goes hand in hand with an inventory of wastes and deficiencies of existing equipment in industrial work, particularly in those plants where the useful life of existing equipment is practically spent. We shall make this inventory of new ideas in equipment and its application once every year and we suggest that you pass this issue around the works among those who are interested in better methods and equipment and then find a permanent place for it where it will be handy for frequent reference during the year.

When You Can't See the Forest For the Trees

EVERY JOB has connected with it more or less detail or routine work which must be thoroughly mastered if the job as a whole is to be successfully handled. Mastery of this detail work is, however, distinctly a means to an end, and not an end in itself. Failure of executives to make good in their positions can, in many instances, be traced to the fact that they did not recognize and apply the principles of this truth to their work.

When one becomes too much engrossed in the details of a job he is almost certain to lose sight of its real purpose and scope. Then the ability to do constructive work is greatly reduced. It is very easy to get so wrapped up in the methods employed in doing a job that the results are overlooked. Methods are, of course, an important element in the success or failure of an undertaking and should receive all of the attention necessary to make sure that they are adequate for the job in hand, but after all, results are what count. They are the yardstick by which the work of every one of us is measured.

It is a good idea once in a while to analyze your job and your attitude towards it. Without an occasional survey of this nature you may unconsciously get so close to your job that, as someone expressed it, "you can't see the forest for the trees."

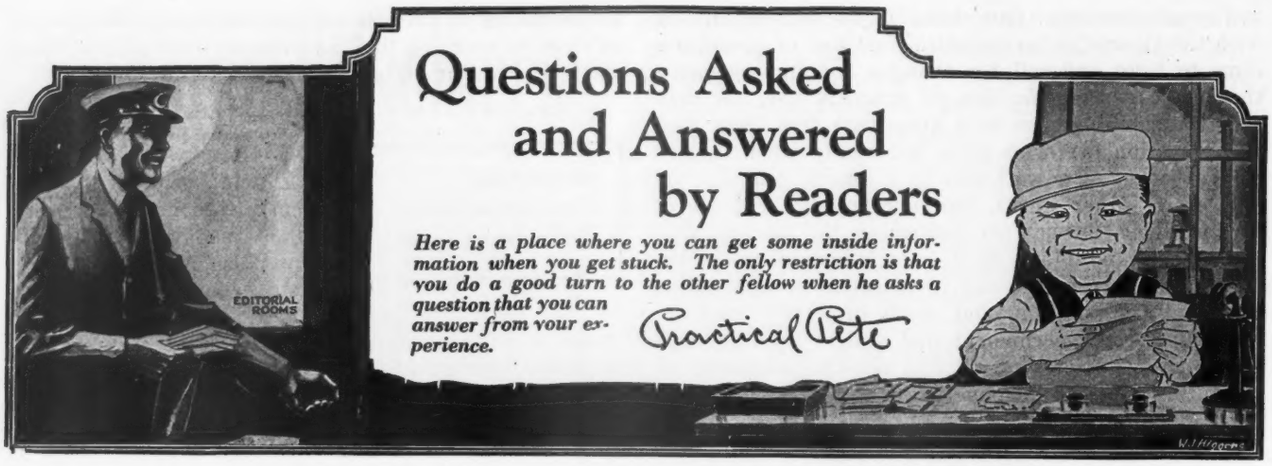
Increasing Production and Reducing Costs

THIS is an every-day and every-night problem in the minds of every plant manager and superintendent who takes his job seriously and although he may do a little better this year than last, he will never be just satisfied. A man of large vision, initiative and with an ambition to make his experience count for all it's worth, is never just satisfied. That's why he's a leader of men and is placed in that position. America is proud of these men and we have them in goodly numbers—they don't just happen, they come in most cases from the rank and file and they get to where they are by dogged persistence and that confidence in experience and ability that we all have, but sometimes fail to show, because some of us are less aggressive in our methods and don't know just how to push our ideas to proper recognition at the right time and in the right place.

But just as a cunning general is not an army and an army without a general is as uncontrollable as a mob, so in industrial work there is a place for every man when every man is in his right place. It's the finding of that place that counts just as much and perhaps more than a title and the responsibilities that go with it. For after all, results count and each and every one of us can get better and larger results in the job we now have if we spend all our time in that direction and stop worrying about the job and results of the other fellow. When you get to know him, you will find that he has his own troubles, too, and the roses that lie in his path have the same kind of thorns, that prick just as deeply as those that you run into now and then.

So when the boss talks about increasing production and decreasing cost don't think he is trying to find a way to eliminate your job or cut your salary. In ninety-nine cases out of a hundred he is inviting you to show the leadership you possess on your job and giving you the opportunity to do something that you have been waiting for. This opportunity will not come headed by a brass band—it slips up quietly and hangs around you in one form or another all the time. It's like the radio waves these days. Anyone can tune in the strong signals, but to bring in the weak signals you have to have the proper receiving equipment, a lot of patience and stay with them until all at once—in they come.

Plant managers are determined to make more money this year than last. They made enough last year to spend a little this year to still increase the net without working overtime and taking on more business than can be handled with the equipment available. If you are down where the wheels go around you are the man who knows how to get a little more out of the machines now in operation, how to prevent interruptions and breakdowns that cost money, how to improve existing methods to save time and how to stop the leak or the trouble that has happened repeatedly on a particular group of machines at the wrong time. That's your opportunity today—go to it, tune it in. You can do it if you think you can and won't give up.


EDITORIAL ROOMS
Questions Asked and Answered by Readers
Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.
Practical Pete

Who Can Answer These?

Winding Data for Transformer of Rectifier—Can some reader of INDUSTRIAL ENGINEER tell me how many turns there are on the transformer of a 5-amp. Tungar rectifier? I dismantled my rectifier sometime ago and have lost the winding data.
Valparaiso, Ind. A. T. M.

* * * *

Simple Thermostat for Electric Oven—I should like to have some reader tell me how, and of what metal, to make a simple thermostat that can be adjusted. This thermostat will be used on an oven that will be heated to temperatures ranging from 212 deg. F. to 1,000 deg. F. and at no time will the current exceed 250 volts and 5 amp. I want to use this thermostat also for indicating by connecting it to a lamp circuit. J. G. B.
Masontown, Pa.

* * * *

Effect of Armature Coil with Reversed Polarity—Sometime ago this question was raised in our shop: Will a reversed polarity coil in an armature burn out while running, or what effect will it have on the armature?

I contend that in order to burn out a coil a heavy current must flow in that coil, which could only be caused by a short circuit. As all coils are connected in series, current of the same amount would flow in each; if one were reversed it would oppose the action of the others and having only the same amperage through it as the others it could only oppose with the strength of one coil, and would neutralize one armature coil.

I should like to hear from some of the readers of INDUSTRIAL ENGINEER on this question.
McKeesport, Pa. E. K.

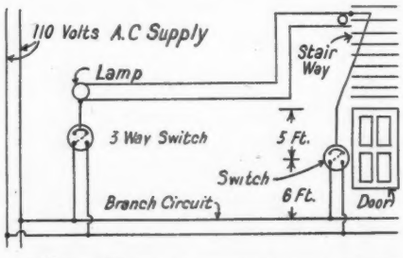
* * * *

Portable Electric Grinder Lacks Power—I shall appreciate it if some of our readers will answer the following questions. I have a single-phase portable grinder which has two windings, starting and running, but the motor does not seem to have sufficient power when grinding. I should like to know if this motor could be re-connected for three-phase operation, eliminating the automatic cut-out on the rotor. The motor has twenty-four slots $\frac{5}{8}$ in. deep and $\frac{5}{16}$ in. wide. The iron back of the slots is $\frac{3}{8}$ in. thick. Inside diameter of stator is $3\frac{1}{8}$ in., length of stator $2\frac{1}{2}$ in., diameter of rotor $3\frac{1}{16}$ in. If this change is possible, what size wire and how many turns should be used and what will the pitch be? I should like to have it operate at 3,600 r.p.m.

I have a small blower motor which operates at 220 volts direct current, and wish to change it to operate at 110 volts direct current. Will I have to reconnect the armature or should it be entirely rewound? The commutator has twenty-four bars and the armature has twelve slots.
Medina, Ohio. C. F. N.

* * * *

Protecting Wires from Mechanical Injury—How should the 5-ft. stretch of wire from floor to switch, shown in the accompanying diagram, be run for proper protection from mechanical injury? Knob and tube work is used throughout on this job, and the wire in question is to be installed in an unfinished stairway leading to a



cellar. There is no partition through which to fish the wire. Further, when the wall of the stairway is finished it is to be back-plastered; so there will be no partition even then. I shall appreciate it if some reader can tell me the best way to meet the above conditions.
Concord, Mass. D. F.

* * * *

Construction of Alternating-Current Magnet—What information can the readers of INDUSTRIAL ENGINEER give me about making a coil for an a.c. magnet to operate on 110 volts, 60 cycles? This magnet should be able to lift about 2 lb. and will be controlled by a float switch, which will open and close the circuit. I should like to know what kind of core would be best, and the amount and size of wire required. Which would be better, a long coil or a short one? I shall appreciate it very much if some reader can give me this information.
Pembroke, Ont., Can. G. B. A.

Answers Received To Questions Asked

With reference to the trouble experienced by R. I. G. with two portable electric drills, as reported in the December issue, I would suggest that he check up the following points: (1) Is the frequency of the circuit correct for the drills? (2) Are the field coils all of the proper polarity, that is, north, south, and so on? (3) Are the fields connected in series when they should be in parallel for 110 volts? (4) Has the stator shifted in the casing, thus throwing the brushes out of line? This is a very likely cause of the trouble and can be checked by moving the front bracket around a little at a time and checking the speed at each setting. Use a C clamp to hold the bracket while testing.

If the trouble cannot be located in the above manner it would probably be best to send the two drills back to the manufacturers.
Detroit, Mich. A. C. ROE.

* * * *

In answer to one of H. C.'s questions in the October issue, I am giving a quick method that I have used for removing the coils from partially-closed-slot armatures. A pry, made from a piece of pipe, has a slot cut in one end large enough to fit over the number of wires of the coil which is to be removed from the stator. After obtaining sample coils and checking the connections, all of the coils on the side where the jumpers are located are cut close to the slot with a pair of diagonal pliers. The stator is then laid flat on this side and the slot in the pry inserted in the loop of a coil. The coil may be easily pried out, using a block of wood for the heel of the pry when necessary. A stator or

armature can be stripped very easily in this manner. S. H. SAMUELS.
San Francisco, Calif.

* * * *

Trouble with Balance Coils on Lighting Circuit—I recently had trouble with a lighting circuit which was to be supplied by a 440-volt, 60-cycle generator. We wanted to get 110 volts, but the only apparatus available to make this change was two Westinghouse balance coils, built for reducing 220 volts to 110 volts. Numerous connections were tried, such as hooking up the two coils in series across one phase of the 440-volt lines, but the balance coils just would not balance the load. One circuit would receive about 150 volts, while the other would show only 85 volts.

Can anyone who has had wider experience than I in this line suggest a way to make these coils work together? Or can you tell me just why they will not work?
Smackover, Ark. W. N. T.

In reply to the question asked by W. N. T. in the November issue of INDUSTRIAL ENGINEER, I would say that two balancer coils as described cannot be operated in series to give balanced voltages unless the loads are balanced as to the coils and are all equal, in which case, of course, there would be no object in using the coils. The difficulty lies in the fact that you have two separate magnetic circuits. With loads on one coil and not on the other, the unloaded coil acts only as an impedance, in which case the voltage across the unloaded coil will vary according to the amount of current being drawn through it. I do not know of any way in which two such coils can be successfully used for the purpose. D. C. HERRICK.

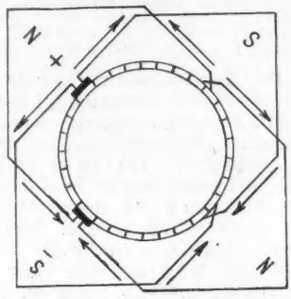
Electrical Engineer,
National Lamp Works of G. E. Co.
Nela Park, Cleveland, Ohio.

* * * *

Path Followed by Current in D. C. Generator—I wish some reader would show by a diagram the commutator connections and the path followed by the current in a direct-current generator which has two poles, 29 segments, 15 slots and 15 coils with a winding pitch of 1 and 4. The machine has two brushes set at 90 deg. I removed a short circuit from the armature of this machine and afterwards drew a diagram to trace the current. Owing to the winding pitch I failed to get the right direction of current flow for each coil. I have had considerable experience in winding d. c. and a. c. machines but this is the first time that I have seen a machine of this design.
Libby, Mont. J. Q. W.

In the October issue of INDUSTRIAL ENGINEER J. Q. W. asks for the commutator connections and the path followed by the current in a two-pole, direct-current generator. I believe that the accompanying diagram will give him this information.

This is a wave winding and has only two current paths in parallel between brushes, regardless of the number of poles. It is necessary to use only two sets of brushes for a machine of any number of poles, although commutation is better when the number of brushes equals the number of field poles.



Path followed by current in two-pole, direct-current generator.

The wave winding is used in small and medium-sized machines where it is desired to keep the number of coils as small as possible.
Albany, Ga. B. BELCHER.

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Testing and Balancing Small Rotors—I wish some reader of INDUSTRIAL ENGINEER would tell me how to test small rotors for all defects which would cause them to run hot. Will someone also tell me what is the best way to balance a rotor?
Vincennes, Ind. R. M.

R. M. asked in a recent issue about a way to test and balance small rotors. We test small wound rotors for shorts with a growler and piece of tin. For opens and grounds we use a test lamp. If the rotor has both starting and running coils, the leads for these windings must be separated when testing for opens and grounds.

For balancing the small rotors we use two steel rules or scales set up on edge in two wooden blocks and put the bearings of the rotor on the edges of the scales. The heavy side of the rotor always goes to the bottom. Small weights can then be added to the light side, to balance the rotor. GEORGE RINGNESS.
Peoria, Ill.

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In answer to R. M. in a recent issue, about testing small rotors for defects that will cause them to run hot, very common causes of trouble are an overload, loose rotor bars, worn bearings, and, in some cases, too low or too high frequency, or too low or too high voltage.

To test for loose bars, tap each bar with a small hammer and notice if there is a difference in the sound obtained from some of the bars. If the rotor is in good condition it will sound the same all around. Another way is to put the motor in a dark place, start it and when it is up to speed reverse the direction of rotation quickly. This will cause an excessive amount of current in the rotor and if any bars are loose sparks will be seen inside the motor.

If the rotor is not in proper condition have the bars welded, or resoldered, if it is a fractional-horsepower motor. In case of an overload remove load until the motor is working at its horsepower rating.

To balance a rotor put it on balancing wheels; see that the shaft is perfectly smooth and that there is no dust or dirt on the shaft or wheels. Give it a little start and when it comes to rest the heavy side will, if the rotor is out of balance, be at the bottom. Put metal on the top or light part of the rotor until it will stay in any position in which it is placed. P. P. SCRIBAUTE.
San Francisco, Calif.

* * * *

In the question by R. M. in a late issue, I presume that he refers to induction motor rotors. The cause of such a rotor running hot may be due to several things and may not be the fault of the rotor at all. Core loss is one of the main factors and is serious on small motors where the air gap is very small and where proper precautions are not taken in the design of the stator core or stator teeth. It is for this reason that good makes of such motors have what is called closed slots, or on larger sizes magnetic bridges are used so that the magnetic flux as it enters the rotor is spread out more uniformly. The rotor core should be laminated and all electrical contacts between rotor bars and end rings should be good. If the rotor winding is defective the machine will have an uneven torque which will be noticed at starting by the motor not pulling the load or by the uneven hum of the machine as it speeds up. Such defects in the rotor winding can easily be detected by applying a low voltage to the stator and noticing the current on an ammeter while the rotor is slowly turned around by hand. If the rotor winding is not uniform, due to unsoldered or broken bars, the current in the stator will vary considerably as the defective bars pass under the poles. For such a test single-phase or polyphase current can be used, but the ammeter need be placed in

only one phase. Any voltage that will give a good reading is all right.

To R. M.'s last question, I would say that the rail method of balancing is by far the easiest for all ordinary rotors and if care is taken it is quite satisfactory for ordinary-speed machines. The main fault with rail balancing is that it does not indicate on which end of the rotor to place the weight, which is important for very good balance. When a rotor so balanced does not show up good on running, it should be placed in a lathe and carefully watched for such defects as a crooked core or other lack of uniformity in such parts as the end rings or flanges. If such defects are noticed they must either be removed or weights added to counterbalance them.

PHILIP G. BERNHOLZ.

East Orange, N. J.

* * * *

In his question in a recent issue, R. M. does not say whether he is referring to wound or squirrel-cage rotors. Wound rotors will heat from overload, worn bearings, loose connections in the commutator and a loose or dirty short-circuiting ring. Squirrel-cage rotors will heat from overload, worn bearings, and loose connections of bars in the end rings. Low voltage will cause both types of rotor to heat.

When balancing small rotors I find out, by any of the usual methods, which is the heavy side and then fasten on the opposite side enough small pieces of brass to balance the two sides. Another method which I have sometimes used is to drill small holes on the underside of the bars on the heavy side of the rotor.

Albany, Ga. B. BELCHER.

* * * *

In answer to the question by R. M., in a late issue, we presume that he is referring to squirrel-cage rotors used in induction motors. We find that many of the older type rotors run hot and do not pull their load, due to some of the bars coming loose from the short-circuiting end rings. Sometimes this condition is not visible and the rotor is apparently in good condition. Our method of locating this fault in the case of a two-phase or three-phase motor is to pass a single-phase current of about half-voltage through one phase of the stator winding with an ammeter connected in series. The ammeter will show a reading and by turning the rotor over by hand very slowly the reading will be constant in the case of a good rotor, but will fluctuate with a rotor which has open circuits in the bars. We use acetylene welding to repair rotors with loose bars as this makes a permanent repair job. In the case of split-phase motors the starting winding should be disconnected from the circuit when the ammeter test mentioned above is made.

KOONTZ BROS. ELECTRIC CO.

South Bend, Ind.

* * * *

How Do You Explain Operation of Variable-Speed Induction Motor?—I would like some help from readers of INDUSTRIAL ENGINEER on the following questions: (1) In a variable-speed induction motor how does the rotor cut down the speed when the field is revolving at full frequency speed? Please explain briefly the theory. (2) Why are the slots in a Westinghouse 30-hp. rotor on a considerable slant instead of straight across and parallel to the shaft?

Chicago, Ill. V. L.

In a recent issue, V. L. asked, (1), how a variable-speed induction motor operates. A brief explanation of the principle of the induction motor will help to make this subject clear. It is understood that the revolving field set up in the stator or primary winding induces an electromotive force in the secondary or rotor winding and that the current flowing in the rotor circuit depends upon the rotor circuit resistance disregarding the rotor counter e.m.f.

At no-load the rotor will run at nearly the same speed as the field, the frequency of the rotor magnetism will be practically zero and there will be very little torque developed. When a load is put on the motor the speed of the rotor in r.p.m. falls, thus causing a slip or difference between the speed of the field and the rotor. This slip increases the frequency of the rotor circuit; this in turn increases the e.m.f. of the rotor thus causing more current to flow in the rotor, which in turn produces enough torque to pull the applied load. This process would continue until the pull-out torque of the motor is reached. In the above example it was the applied load that caused the speed to drop. The drop in speed runs 3 to 7½ per cent.

From the above it follows that the resistance of the rotor limits the amount of current; that the e.m.f. necessary to force this current through the rotor depends upon the frequency of the rotor magnetism and that the speed is susceptible to a change in the rotor resistance. Take the case of a slip-ring motor working against a constant torque. If resistance is inserted in the rotor circuit a higher e.m.f. in the rotor is necessary to force the required current through to keep the torque constant, the rotor drops off in speed, thus increasing its frequency and its e.m.f. If the slip at a given torque and rotor resistance is 15 per cent, then the slip will be 30 per cent if the resistance of the rotor circuit is doubled. Therefore, increasing the resistance of the rotor circuit decreases the speed and decreasing the resistance increases the speed. This change in speed is brought about by transformer action between the primary and rotor.

(2) The slots of induction motor rotors are skewed or slanted to prevent dead spots. In some of the old motors where the ratio of stator to rotor teeth was not within certain limits there were dead spots; that is, when the rotor stopped in certain positions it could not be started again without turning it slightly.

Detroit, Mich. A. C. ROE.

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Preventing Corrosion of Iron Storage Battery Racks—I should like to ask your readers what treatment can be given to iron racks for storage batteries which will prevent the spilled acid from attacking the iron. We use the lead type of battery filled with dilute sulphuric acid. We have a large number of storage batteries and recently some iron racks have been constructed. All of these racks were painted with several coats of the best grade of asphaltum black paint but this does not protect the iron when acid is spilled on it, nor does any kind of paint that I have tried.

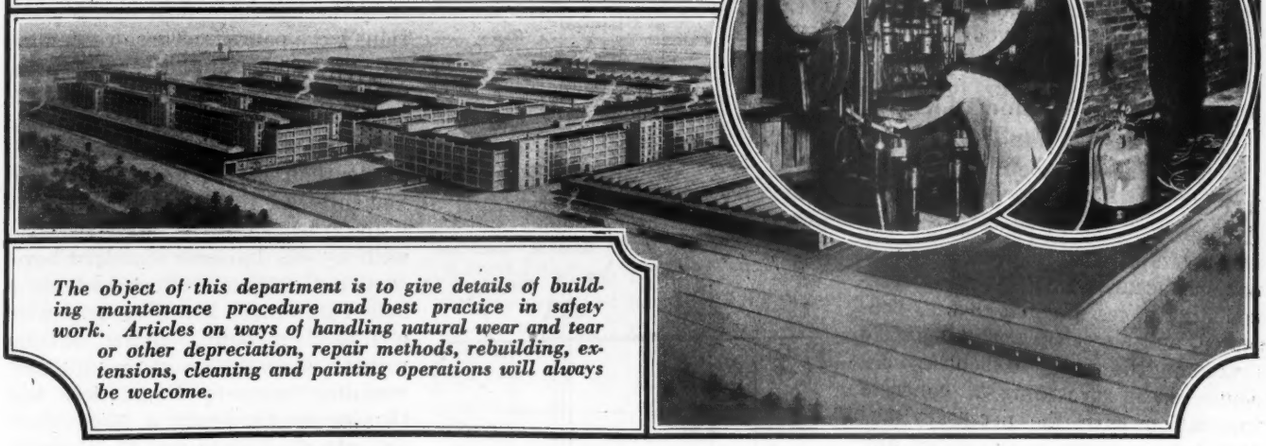
We have had considerable trouble due to the corrosive effect of the acid forming a substance resembling sand which falls into the jars below. This produces excessive iron in the solution, making a change of acid necessary. I shall appreciate it if anyone can tell me how to overcome this.

Atlanta, Ga. J. B.

Referring to the question by J. B. in a recent issue, there is on the market a protective medium known as Gardco which is very resistant to the action of acids, acid fumes and brine. In direct tests it has been subjected for hours to steam and the fumes of muriatic and nitric acids and was only slightly affected. I have had on my desk for more than two hours a sheet of tin covered with this product on which there were placed three drops of sulphuric concentrates and it showed hardly any effect. I believe it would be worth while for J. B. to try out this product and he can satisfy himself very quickly through his own tests whether or not it will solve his problem. IRA D. LOCKWOOD.

Buffalo, N. Y.

Building Maintenance and Plant Safety



The object of this department is to give details of building maintenance procedure and best practice in safety work. Articles on ways of handling natural wear and tear or other depreciation, repair methods, rebuilding, extensions, cleaning and painting operations will always be welcome.

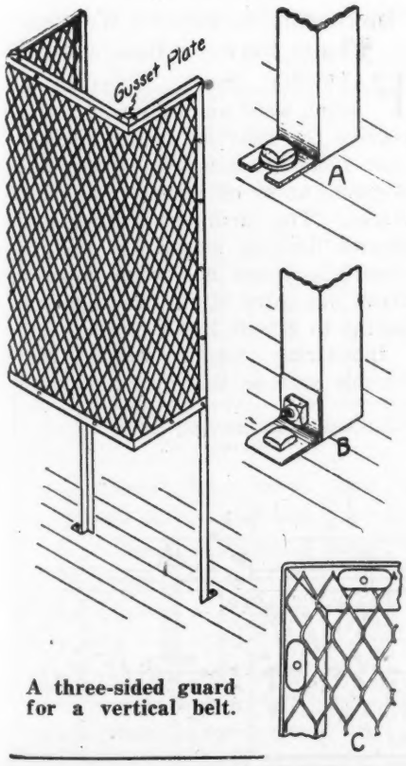
Easy Method of Building Machine Belt Guards to Fit Conditions

PRACTICALLY every machine must have some form of guard around an open belt. These requirements are specified by the insurance companies and by the state factory inspection bureaus. Because of the wide variation in sizes and angle of inclination of belts, it is frequently difficult to purchase guards ready made for all locations, and so it is common practice in a large number of industrial plants to make the guard to fit conditions. One common method is to use sheets of expanded metal (North Western Expanded Metal Co., Chicago, Ill.) which are held together by angle-irons. How this may be done is shown in the two accompanying sketches. Both of the guards shown are common types and well indicate the possibilities.

When making guards for vertical and inclined belts, one side of the belt is frequently protected by the frame of the machine and so a three-sided guard is all that is necessary. Ordinarily, when three-sided guards are used, and the oil holes are inside the guard, it is necessary to provide a door. The common practice is to have the guard attached to the floor and to the machine frame with bolts or thumb screws. In such cases where it is necessary to get at the pulley or belt for repairs, the complete guard can be easily removed.

In case a four-sided guard is used, it is usually necessary to provide one removable side or door. The door as shown in the accompanying illustration is but little more expensive than the removable side and generally is recommended. Short-length doors are recommended as they are stronger and brace the guard more easily than is possible with a full-length door. If the whole side is removable, the edge of the expanded metal is fastened by U-edging and bolted to the frame work of the guard. Doors are also made with U-edging and hinged to the angle-iron framework.

For ordinary work, the expanded metal sections after being trimmed to size and shape by a chisel or a shear, are fastened to the angle-iron framework by bolts and small plates as shown in *C* of the accompanying illustrations. Two methods of fastening the frame work to the floor are also shown. These expanded metal sheets are made up of 18 or 13 gage sheet with a diamond opening 1¼ in., 2½ in., 4 in. or 6 in. long. The sheets come in standard sizes about 4 ft. by 8 ft. or 6 ft. by 8 ft. These may be cut into any

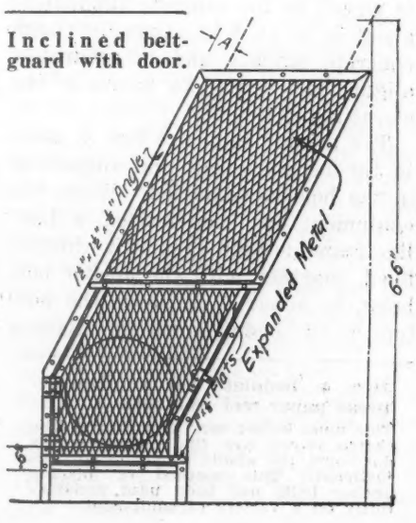


A three-sided guard for a vertical belt.

These sketches show how guards may be built up for belts.

After the expanded metal is cut to shape, the edges are fastened together by angle-irons, which also act as a framework to support the entire construction. The sketches show the construction of both the vertical and the inclined guard. Care must be used in constructing inclined belt guards so that ample clearance is allowed for the flap of the belt on the loose side.

Inclined belt-guard with door.



shape and fastened together with angle-irons so as to fit practically any conditions. In plants where these expanded-metal guards are made up to fit the job quantities of these sheets, angle-irons and U-edgings are kept on hand and cut according to specifications for any particular guard.

Simple Method of Installing Anchor Bolts for Bedplates and Machines

IT IS comparatively difficult and impracticable to place or set anchor bolts rigidly in concrete foundations accurately to fit the corresponding holes in slide bases, bedplates, and electrical apparatus. To overcome the many difficulties encountered in providing a concrete foundation with the necessary anchor bolts accurately placed for any equipment, the following method has been found very satisfactory, economical, and practical.

The layout of the anchor-bolt holes is obtained from a blueprint or measured directly on the apparatus to be installed. The centers are laid out on the foundation, and a square hole chipped out, the size and depth depending upon the size of bolts used. If a new foundation is to be built the holes can be provided for by setting square or rectangular forms in the desired location when pouring the concrete foundations.

The illustration below shows a cross section of a foundation and indicates the method of placing the anchor bolts in the bedplate of a printing-press drive equipment. The 10-in. square by 8-in. deep holes are provided at the time the foundations are made and are used for a 1¼-in. anchor bolt. The printing-press drive is placed on the concrete foundation about ¾ in. to. 1 in. above the rough concrete surface and is accurately aligned and leveled by means of the elevating screws *A*.

The anchor bolts are put in place in the bedplate lugs and suspended in the hole as indicated. When the equipment has been leveled, a box-like frame is built around it which is filled, together with the anchor bolt holes, to about 1 in. above the bottom of the bedplate with a mixture consisting of cement with one or two parts of sand. After 24 hr. the wooden frame can be removed and in three to six days later the equipment may be put into service.

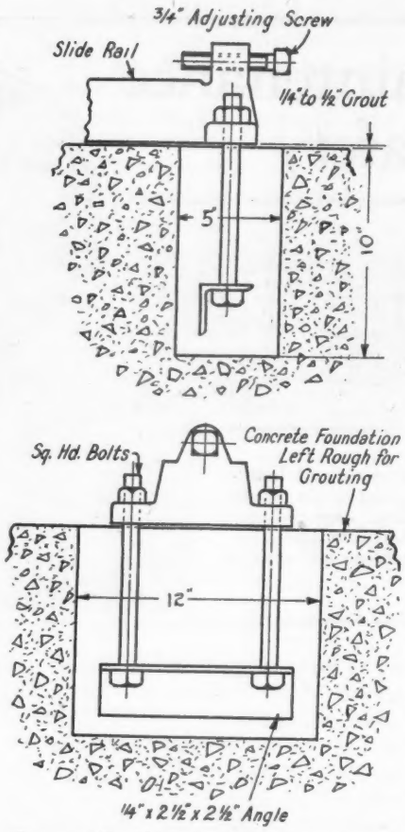
Another method of anchoring slide rails or bases for motors is to use a standard bolt with a piece of angle-iron as an anchor and also to prevent the bolt head from turning. This can be set in the foundation or in a box opening and grouted in afterward. The two sketches above show how a slide-rail for a motor or other machine may be set by this method.

The magazine paper reels as used for feeding newspaper printing presses, installed underneath the presses on concrete foundations, were installed by the above method. The anchor-bolt holes were all laid out from the blueprint plan and the anchor-bolt holes provided at the time the basement floor and foundations were poured. These reels must be accurately aligned with press parts and level, which was easily accomplished because of the variation permissible in the shifting of the anchor bolt before grouting in permanently.

In a test a ⅝-in. standard bolt with a 3-in. diameter standard bevel cast-iron washer was grouted in a hole 4-in. square and 6 in. deep with a 1 to 2 mixture. After several months when the grout and the surrounding concrete foundation had thoroughly hardened, a 20-ton jack was attached by means of chains to the extending end of the ⅝-in. bolt with two nuts locked together to hold the chain. The pull on the bolt was applied gradually with the result that the threads stripped, but the bolt was not withdrawn from its position, nor did it break out the foundation. In this case the concrete foundation was 12-in. thick and made of a 1-2-4 mixture.

E. H. LAABS.

Engineer, Printing Equipment Dept., The Cutler-Hammer Mfg. Co., Milwaukee, Wis.



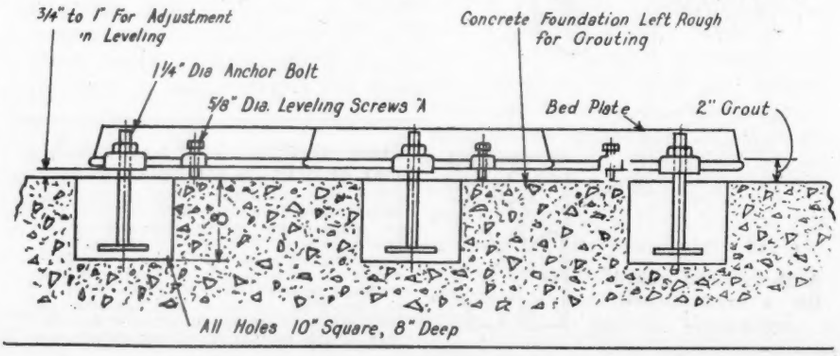
One method of installing anchor bolts.

A rectangular hole, large enough to take the two anchor bolts is left in the foundation. The heads of the bolts are prevented from turning by the strip of angle iron. After the rail is carefully placed and lined up the rectangular opening is filled with cement. Sufficient space is left for grouting.

Easy Method of Increasing Service of Wooden Floors Between Renewals

FACTORY floors, if made of wood, wear unevenly where they receive the heaviest traffic, such as that from trucking or from men stepping on or off elevators or other places. The ordinary tongue-and-groove flooring starts to splinter when the board has worn down to about one-third of its thickness and begins to expose the groove.

Industrial plants which have trouble such as this may use to ad-


¾" to 1" For Adjustment in Leveling
Concrete Foundation Left Rough for Grouting
1¼" Dia Anchor Bolt
⅝" Dia. Leveling Screws A
Bed Plate
2" Grout
All Holes 10" Square, 8" Deep

How a bedplate for a printing-press paper-reel was set.

This must be set very accurately. The sketch shows how the anchoring was done and the ample provision for adjustment. This method of placing anchor bolts has been used satisfactorily on a variety of equipment.

This special tongue-and-groove joint enables flooring to be worn down to almost half its thickness before the groove begins to splinter and renewal becomes necessary.

vantage the plan adopted by a street car company for platforms to meet a similar difficulty. These floors had been made of 13/16-in. hard maple boards 3¼ in. wide and it had often been found necessary to renew the flooring because of the wearing down to the groove, even though it still had sufficient strength. Finally, the special tongue and groove shown in the accompanying sketch was adopted. This enables the floor to be worn down to almost half its thickness before the groove becomes so thin as to be likely to splinter or the crack to open up. Industrial plants using this flooring for heavy trucking would probably use a thicker board but could get more wear by off-setting the tongue-and-groove.

What Wasted Air, Steam, Water, Gas and Light Cost Per Month

ONE of the most important and profitable parts of plant maintenance lies in stopping the wastes due to the miscellaneous little leaks. A hissing flow of air or steam or even a dripping of water from a poor joint or worn-out packing in a valve or faucet costs money. Because but few men engaged in this work realize the value of these losses it may be well to look over the accompanying table which appeared in "The Studebaker Co-Operator" to show the workers of The Studebaker Corporation how these seemingly trifling losses mount up, if neglected for a month.

Water, air, steam, gas and electricity all cost money. A number of little leaks can easily in the aggregate, amount to the equivalent of a large leak; so it is not always necessary to have a half-inch opening to make the loss equivalent to many times the cost of repair. Some of this loss is no doubt due to carelessness, but much of it is due to a lack of appreciation of what it means to avoid waste even though it may be small. Economy comes from many little savings more often than from a few big ones because if the little ones are passed up, there is less likelihood of the larger savings being recognized and taken advantage of.

Chicago, Ill. E. D. F.

Proper Maintenance Stops These Wasting Leaks and Saves These Losses

Size of Opening	Air		Steam		Water		Gas		Electricity		
	Number of cu. ft. wasted per month 100 lbs. pressure	Total cost of waste per month @ 10c per M cu. ft.	Number of lb. wasted per month 100 lb. pressure	Total cost of waste per month @ $1.00 per M. lb.	Number of gal. wasted per month 40 lb. pressure	Total cost of waste per month @ 9½c per M. gal.	Number of cu. ft. wasted per month 4 in. water col. pres.	Total cost of waste per month @ $1.00 per M. cu. ft.	Number of 350-watt Cooper-Hewitt lamps left burning.	Number of kw.-hr. wasted per month.	Total cost of waste per month
½ in.	17,800,000	$1,780.00	805,500	$805.50	1,250,000	$118.75	141 0	$141.00	25	6300	$142.50
⅜ in.	9,980,000	998.00	462,000	462.00	692,700	65.81	79,100	79.10	20	5040	114.00
¼ in.	4,450,000	445.00	203,500	203.50	308,000	29.26	35,300	35.30	15	3780	83.50
⅛ in.	1,114,800	111.48	56,000	56.00	77,000	7.42	8,850	8.85	10	2520	57.00
1/16 in.	278,700	27.87	13,000	13.00	19,500	1.85	2,210	2.21	5	1260	28.50
1/32 in.	69,850	6.99	3,200	3.20	4,900	.47	553	.55	1	252	5.70

Liberal Use of White Paint Helps to Keep the Plant Clean

SOME plants, particularly those in the food industry, paint the equipment white, as well as the walls and ceiling, because white shows dirt so plainly that there is no excuse to overlook it. This same plan was also used in the glue room of another plant, where the manager took pride in good industrial housekeeping. As a result the whole room was painted white. Now when any glue is spilled it shows up so conspicuously that it is immediately wiped off before it dries and becomes too hard to loosen.

Red Card Indicates That Used Extinguisher Needs Refilling

IN THE excitement incidental to a fire drill or the use of a portable fire extinguisher, the latter is often put back into place without being refilled. A practical way to indicate the need of refilling a used extinguisher is to have a strong yellow or white envelope, which has printed on the outside, "When Used Withdraw Red Card," wired to handle. The red card within the envelope is also attached by a strong cord or wire to the extinguisher. With the red card in view, the foreman of that department will notice it and promptly report it to the maintenance foreman, particularly if he is held responsible should the extinguisher be found empty. When the extinguisher is re-filled the red card is again inserted in the envelope.

It is a good plan to make a test of fire-fighting equipment and personnel about once every two weeks, by having an alarm sent in from a different location each time. In addition, it is well to have the electric pump operate at full speed, the hose run out, the extinguishers brought out and tarpaulins transported to the scene. Have at least one extinguisher play on the "fire." It is also well to work a chemical hose cart for a few minutes. When the fire is out, it is well to have the bell system or whistle sounded once or twice to indicate to the foremen that the firemen, who have responded from various departments are now ready to return to their work. H. S. RICH.

New Britain, Conn.

SERVICE
around the works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.

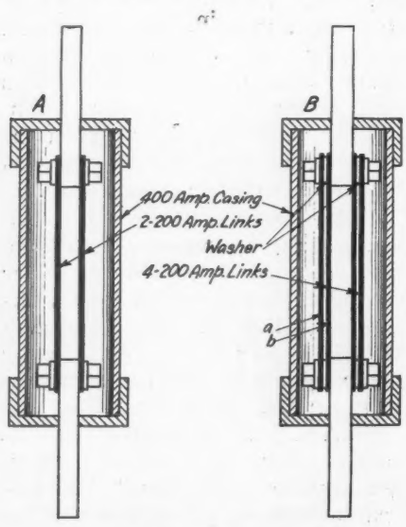
Improper Alteration of Renewable Fuses Causes Trouble

A LARGE manufacturing plant was periodically closed down due to a failure in the power supply through the blowing of a set of renewable fuses. The length of the shutdown depended on the length of time required to replace the damaged links. These shutdowns cost about $400 in wages of idle men, with a loss of production that could not be accurately determined. A rough estimate would be $2,000 loss for each shutdown. At one time there were four shutdowns in six weeks.

Naturally, the manufacturer first blamed the power company. The result was that the engineers of both companies involved finally made a concerted effort to find the cause of the trouble. At first the belt on a 200-hp. synchronous motor was blamed, but after a careful investigation this possible cause was eliminated. Then underground-cable disturbances were looked for without any definite results. At length, the set of renewable fuses was examined and the cause of the difficulty found. The fuse casing was designed for 400 amp., and with the addition of two extra fusible links an 800-amp. circuit was apparently protected. In reality, however, such an arrangement gives only about 600-amp. capacity. The illustrations show the correct method of inserting the links and the incorrect way of raising the capacity by adding extra links.

In Fig. *A* the heat in the link has ample space to radiate in all directions, but in Fig. *B* the two links, *a* and *b*, are so close together that their temperature rises unduly, due to the fact that the heat does not escape fast enough. Of course, 800-amp. fuses should have been used in the first place but electricians are sometimes prone to alter an existing fuse rather than put in larger fuse blocks. As a solution of the difficulty the fuses were replaced by copper bars and the incoming circuit breaker was adjusted to open in time to protect the equipment against any serious overload.

New Haven, Conn. HERBERT J. WOLF.

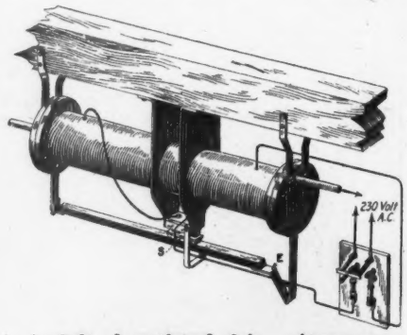


Proper and improper method of increasing capacity of renewable fuses.

In *A* two 200-amp. links are used to make a 400-amp. fuse. As shown in *B* two extra 200-amp. links were used to increase the capacity to 800 amp., but it was found that this combination would carry only about 600 amp., as the temperature of the links was higher than normal.

Construction of Simple Electric Water Heater for Shop Use

TO FURNISH hot water for washing purposes, an electric heater which has given good service was recently made in the shop of an industrial plant. A piece of 6-in. pipe, 6 ft. long, was flanged at each end and after two outside plates were bolted to these flanges, the pipe was insulated with two layers of scrap mica shellacked on, followed by a layer of asbestos tape. After this 360 turns of No. 11 asbestos-covered wire were wound on the pipe, leaving about ⅛ in. between turns. After winding the ends were tied down with asbestos tape and brought back about 6 in., to prevent any mechanical strain on the winding. The winding was then plastered over with a mixture of fire clay containing a small amount of finely-broken magnesia pipe covering. This coating was wrapped with



A 6-ft. length of 6-in. pipe was wound with asbestos-covered wire. Overheating is prevented by utilizing the expansion of the pipe to open the switch at S and break the circuit.

another layer of 4-in. asbestos tape.

To prevent damage in case the power switch should be left on, the expansion of the drum was utilized to open the circuit. An oil-treated, 1½-in. by 2-in. maple bar was hinged at one end to the drum as shown in the illustration. One end of the bar was fitted with a steel plate which rests on an adjustable steel edge, *E*, supported from the end of the pipe. A copper plate, *S*, was attached to the bar. Above it is a small insulating base with two spring contacts which touch the copper plate on the bar. When the bar is held up the circuit is completed through this plate. When the drum expands the bar drops and breaks the circuit. A stop is provided, as shown, to prevent the bar from dropping too far.

This switch acts only as a safety valve and not as an energy saver. It was found that because of the hot water rising to the top the drum tends to bend, and so the linear expansion is much smaller than was expected, although it is sufficient to operate this safety device. A test made on the heater before it was installed showed that on a 220-volt circuit it heated water from 70 deg. F. to boiling in about 30 minutes. The efficiency was found to be approximately 83 per cent, and the power factor 94.7 per cent.

New York, N. Y. EUSTACE C. SOARES.

Two Schemes for Controlling Lights from Two Points

WHEN it is required to install lights to be controlled from two different locations, they may be connected as shown in Figs. 1 and 2.

A case recently came to the writer's attention in which it was necessary to wire some garages for lights to be controlled from the residence and in the garage, and in addition have current available at all times for a heater, portable tools, extension lights, etc. In this case it was found preferable to wire the lights as shown in Fig. 2, as it permitted connecting the above mentioned accessories across lines L_1 and L_2.

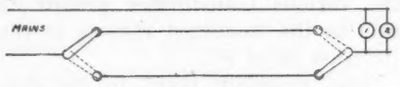


Fig. 1—Connections for three-way switches for controlling lights from two points.

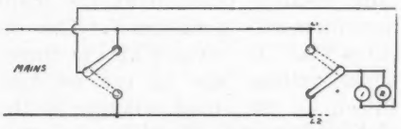


Fig. 2—A scheme for controlling lights and other socket devices by use of three-way switches.

This made current available at all times, regardless of whether the lamps 1 and 2 were lighted or not, whereas with the connections arranged as shown in Fig. 1 this could not be done. P. JUSTUS.

Superintendent, Electrical Dept., Chandler Motor Car Co., Cleveland, Ohio.

Method of Installing Ball and Roller Bearings

IN THE application of ball and roller bearings to motors, the service given by the bearings depends, (1) on the proper selection of the bearings, (2) on the right kind of lubricant properly applied and (3) on the care with which the bearing is installed. The best bearing can be spoiled by careless handling or by improper installation.

The press fit allowance for mounting bearings on the shaft varies from about 0.0010 in. to 0.0015 in. for sizes of shaft between 2 in. and 4 in., and for other sizes in proportion.

A ball bearing should be pressed on by applying pressure to the inner race only; in no case should a hammer be used directly on the bearing. The damage done by a hammer may not be noticed at the time, but the life of the bearing may be cut down 50 per cent.

The accompanying illustration shows a method which I have found satisfactory for pressing on or removing ball bearings from motor shafts. As will be seen at *A*, a hole ¾ in. or 1 in. deep is bored in the center of the shaft and tapped for a stud or bolt a foot long. This bolt is threaded the full length and the end is squared so that it can be screwed into or out of the end of the shaft with a wrench.

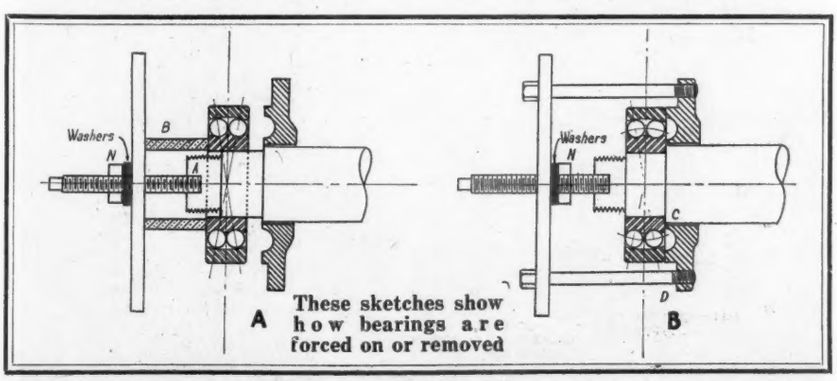
To press on the bearing a brass cylinder or sleeve, *B*, about 4 in. long is used; the inside diameter of this cylinder must be a little larger than the inside of the bearing. A bar of flat iron 1 in. thick and 4 in. wide is bored so that it will slide freely over the threaded bolt. The brass cylinder is first placed against the inner race of the bearing; the flat iron bar is then held against the cylinder and three or four washers coated with grease or vaseline are put on the bolt next to the iron bar. A nut is then screwed on to press against the washers, the bar and the cylinder. If the shaft has been turned to the right diameter the bearing can thus be easily pressed on by using a 12-in. wrench.

The washers are used to prevent the friction of the nut from turning the flat iron bar and possibly displacing the brass cylinder, which must press evenly all around on the end of the inner race.

To press on the pulley-end bearing a piece of iron pipe can be used between the flat iron bar and the cylinder. To use this device for removing a bearing from the shaft, the inner end-cap must be designed as shown at *C* and *D*, in *B*, so that the projecting lips of the end-cap can bear on both the inner and the outer race of the bearing at the same time. Preferably inner lip *C* should be a few thousandths of an inch longer, so as to bear harder against the inner race.

In the case of a spherically shaped outer race such as is used in the SKF ball and roller bearings, pressure applied against the outer race only would produce a powerful wedging action between the outer race and the balls and thus tend to break the outer race, and also to scratch the highly polished surface of the balls, thus shortening the life of the bearing.

To remove a bearing, holes are bored in the flat iron bar the same distance apart as the holes for the



These sketches show how bearings are forced on or removed

bolts holding the end-caps together when the bearing is in and the end-caps in place. In this case the nut *N* is first screwed on to the bolt; then the washers are put on, followed by the iron bar. Bolts of the proper length are run through the holes in the iron bar and threaded into the end-cap as shown. The bearing can then be taken out by turning nut *N*.

Holes of the depth and diameter required for the threaded bolt will not weaken the shaft, as the inside of a shaft carries very little load. The threaded bolt that screws in the shaft may vary in diameter from ¾ in. for a 2-in. bearing to 1 in. for a 4-in. bearing, and so on in proportion to the size of the bearing.

Belleville, Ont., Can. J. H. GALLANT.

How to Connect Transformers for Paralleling 2-and 3-Phase Circuits

A PROBLEM which often arises in changing over an old to a new system of distribution is that of tying together two-phase and three-phase systems. Although the number of two-phase systems in operation is gradually becoming less, it is sometimes necessary to operate together parts of the same system which are different. The particular case described here is somewhat special but may be of interest to those who are compelled to harmonize the operation of two- and three-phase systems.

The general outline of the conditions is as follows: A three-phase 33,000-volt circuit has connected to it two transformer substations *X* and *Y*. At station *X* the voltage is stepped down to a 4,000-volt three-phase, star-connected system. At station *Y* the voltage is stepped down to 2,300 volts two-phase by means of "T" or Scott connections. From station *Y* a two-phase circuit is carried to station Z where the voltage is stepped up to 4,000 volts three-phase.

It is desired to tie together the two three-phase, 4,000-volt circuits. There is danger, however, of making the connections incorrectly so that these two systems cannot be paralleled. The secret is in the method of connecting the transformers in station *Y*. Circuit *I, II, III* must be connected with circuit *IV, V, VI* at junction point *W*, as shown in the drawing.

Fig. 1 shows the actual physical connections for each transformer and might be considered as a practical operating diagram. The ends of the transformer windings have been lettered so that identification of the connections may be complete. Fig. 2 shows the voltage vectors for the various transformer groups as well as the combined vectors at the junction point *W*.

The important point in the connections is that the "teaser" transformer *F* at station *Z* occupies the same relative position as the main transformer *D* in station *Y*. This insures that the vectors of the three-phase voltage are in the position shown by the small triangle to the right of station *Z*. This triangle corresponds to the small triangle to the left of station *X* which shows the position of the voltages generated by the star winding. These triangles it will be noted are rotated 30 deg. from the triangle at the right of station *Y*.

The actual tests required to assure the correctness of the connections can be made with the greatest certainty through voltmeter readings taken through potential transformers connected to the respective circuits and the voltages balanced against each by interconnecting the low-voltage windings of the potential transformers used.

The practical method of testing out the connections would be as follows: At either station *X* or *Z*, or at junction *W*, provide two potential transformers and a voltmeter reading at least double the voltage of the low side of the potential transformer. Through temporary connections readings should be taken of all voltages *I-II, I-III, II-III* and IV-V, IV-VI, V-VI, to be assured that approximately balanced voltages exist in each circuit. Then test as follows: Connect at random, say line *I* to line *VI*. Readings taken between lines *III* and *V* or lines *III* and *IV* with the potential transformers in series

Three-phase and two-phase circuits connected to operate in parallel.

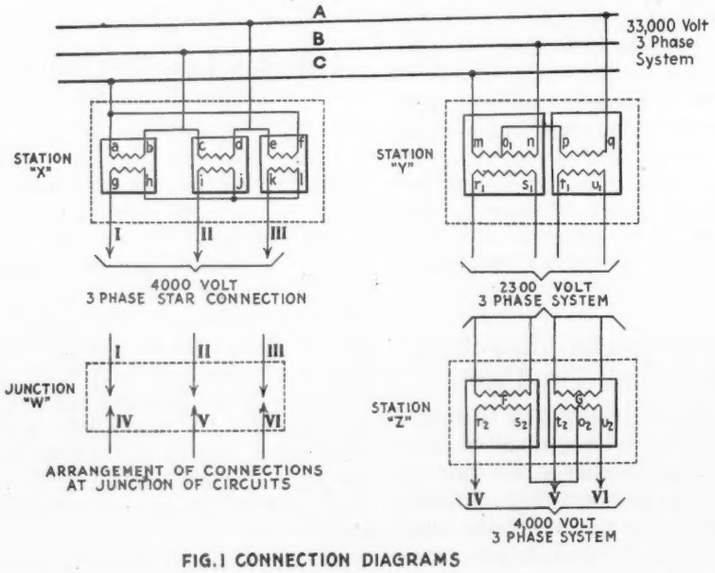


FIG.1 CONNECTION DIAGRAMS

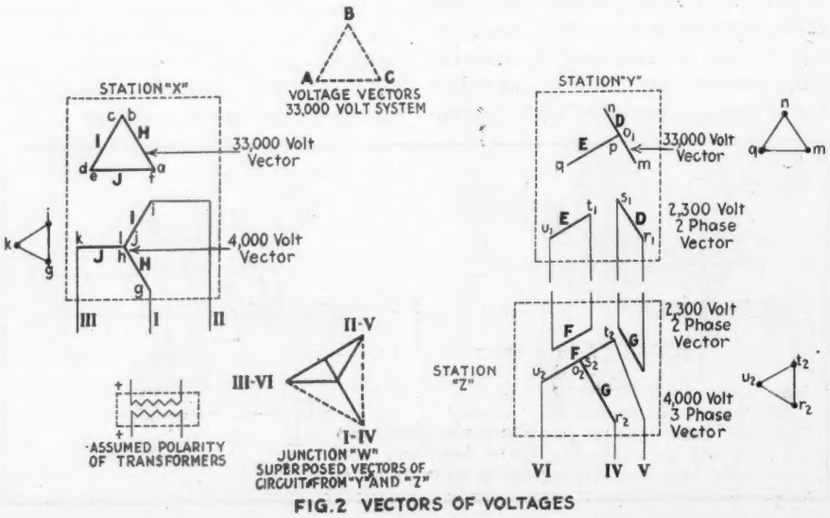

VOLTAGE VECTORS 33,000 VOLT SYSTEM
STATION "X"
STATION "Y"
33,000 Volt Vector
4,000 Volt Vector
2,300 Volt 2 Phase Vector
2,300 Volt 2 Phase Vector
4,000 Volt 3 Phase Vector
STATION "Z"
ASSUMED POLARITY OF TRANSFORMERS
JUNCTION "W" SUPERPOSED VECTORS OF CIRCUITS FROM "Y" AND "Z"

FIG.2 VECTORS OF VOLTAGES

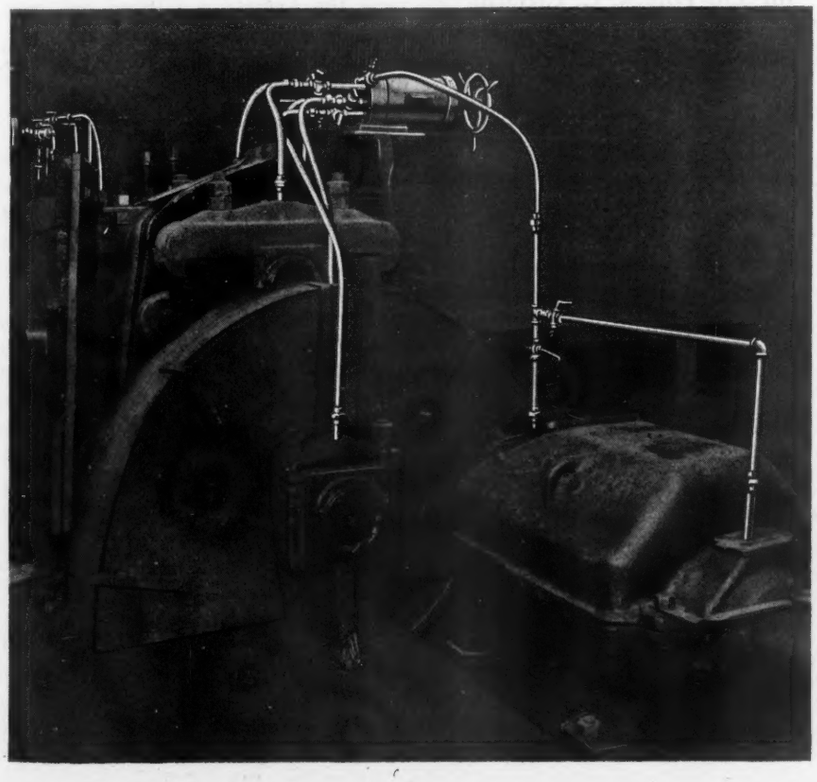
on the high-voltage and low-voltage sides will show a high reading on the voltmeter. The same will be true, of course, if readings are taken from *II* to *V* and *II* to *IV*. If, however, line *IV* is connected temporarily to line *I* a test between *III* and *V* will show normal voltage, but a test between *III* and *VI* will show practically zero voltage. A further check will be to test between *II* and *V* for zero voltage. The connections between circuits can now be made permanent.

It is assumed in this discussion that the polarity of the potential transformers is known.

C. O. VON DANNENBERG.
New York, N. Y.

Fuse Cause of Trouble With Heat Regulator

IN CONNECTION with automatic temperature regulation, we use a controller the moving head of which is actuated by the expansion and contraction of liquid contained in an armored tube that is exposed to the air of the container whose temperature is to be controlled. When the temperature exceeds a certain predetermined value, the hand touches a contact post on one side of the controller; this establishes a by-path which short circuits the coil of a relay the secondary circuit of which energizes the contactor so that the main heating circuit is opened or closed, as the hand makes contact with the stopping post or with the starting post. Trouble was experienced with the regulator hand overshooting and thereby raising the temperature higher than desired. The short-circuiting circuit established by the stopping post was investigated for loose connections, but none was found. The fuse itself was tested for continuity and found to be in good condition. A new fuse was installed, and then another, both being of the same rating as the suspected fuse; with none of the three similar fuses in circuit, could the controller be depended on to shut off the heat at the maximum desired temperature indicated on the recording thermometer and for which temperature the controller was adjusted. Finally the fuse was removed and the fuse clips connected together with a strand taken from a No. 18 extra flexible conductor. Under these circumstances the control was entirely dependable, showing that the fuses themselves were in some way responsible. Next a fuse of the same rating was removed from the starting circuit, in which it had been installed for many months, and put into the stopping circuit, while one of the suspected fuses was installed in the starting circuit. With this interchange of fuses, the control became entirely dependable. This left only one conclusion to be drawn; namely, that the resistance of the fuse was so high that the by-path circuit of which it was a part, ceased to be a short-circuit around the relay coil which thereby was enabled to retain current enough to keep the relay contacts closed. Since changing fuses no further trouble has been experienced. J. A. HORTON.
Brooklyn, N. Y.



Lubrication of the bearings of this cold scarfing machine is made easier and safer by the use of the Keystone Manifold Safety Lubricator, made by the Keystone Lubricating Co., Philadelphia. Pa.

Mechanical Devices in Power Service

(*Continued from page 68*)

Lockwood, Eslick & Pfohl, Buffalo, N. Y., have put on the market an anti-corrosive solution known as Gardco. This material has the appearance of an enamel or paint. It is claimed to prevent corrosion of iron, steel or zinc and to be impervious to the action of acids and alkali.

Glow-Brite Co., Cleveland, Ohio, has developed Glow-Brite, a liquid factory glass cleaner. It is claimed that this material will remove dirt and grime from glass almost instantly.

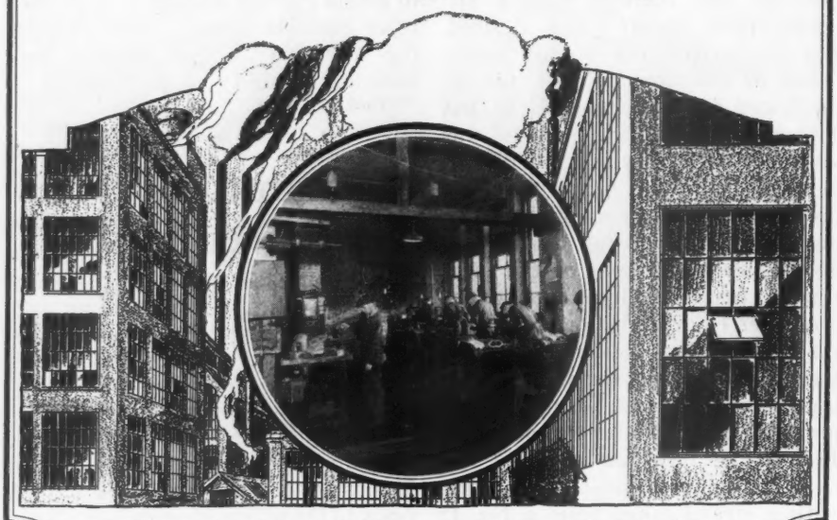
Crown Die and Tool Co., Chicago, Ill., has brought out a portable vise bench. This bench is made largely of malleable iron and is strong and rigid, but light enough to be readily transported.

The Borden Company, Warren, Ohio, has put out two new pipe cutters for handling larger sizes than the cutters heretofore made by this company. These tools can be operated in any position on the pipe by hand or, if desired, they can be arranged for power drive.

Cling-Surface Co., Buffalo, N. Y., is marketing Cling-Surface belt treatment in medium and light densities and in bar form, as well as in the heavy density obtainable heretofore.

Quickfix, a compound for repairing concrete floors has recently been developed by The Master Builders Company, Cleveland, Ohio. When used according to the method specified by the manufacturers, it is claimed that this material will produce permanent patches that can be used two days after installation, as compared with the two to three weeks' period heretofore needed for concrete patches to harden.

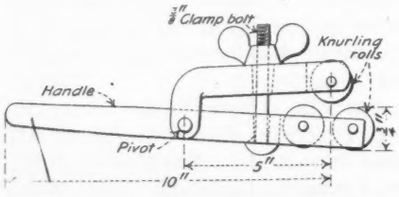
In the Repair Shop



This section is devoted to repair work, large and small. Special attention is given to shop or bench tools and short cuts or improved methods. Contributions are always welcome.

Simple Knurling Tool for Hand or Lathe Use

WHERE a small knurling tool is required for general use the simple tool shown in the illustration will be found to be very useful, as it can be used by itself or in connection with the turning lathe, or the speed lathe. Due to the special clamp construction, it is possible to set the knurling rolls against the work, which is held in a vise or chuck, and use the handle to turn the tool about the work, thus embedding the corrugated faces of the knurls into the surface. When this tool is used on the lathe it is not necessary to use the tool post.



With this tool the piece to be knurled is held in a vise and the tool turned around it by hand.

As shown in the illustration, the tool comprises three corrugated rolls about ¾ in. in diameter which are mounted in two hinged, forged-steel holders. One of the holders is about 5 in. long and is pivoted on the other which is about 10 in. long, the extension on this part forming the handle for holding the tool. A single clamp bolt between the two hinged sections provides a means for holding the knurling rolls firmly against the work. This knurling tool will be a desirable addition to the individual tool kit and can be used on many small jobs without the delay occasioned by chucking work in the lathe or securing a tool-post knurl.

Washington, D. C. G. A. LUERS.

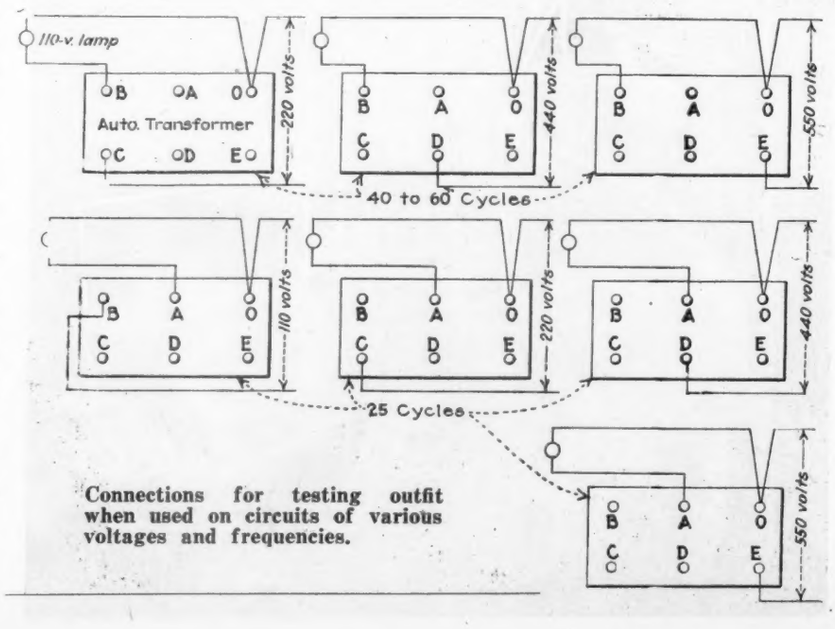
Easily Made and Compact Testing Lamp for Use on 550-Volt A. C. Circuits

IN THE August, 1923, issue of INDUSTRIAL ENGINEER, page 416, I described a handy testing outfit which we use when making tests on 550-volt alternating-current circuits. As was stated before, this outfit consists of one of the small transformers used in connection with the no-voltage release on K-20 Canadian General Electric oil circuit breakers, and an incandescent lamp, mounted in a wooden box.

The diagram of connections for using this outfit on 550 volts was not correct, as given in the article in the August issue. The accompanying illustration shows the proper connection.

Inasmuch as this device may also be used for testing at 440 and 220 volts, at either 25 or 60 cycles, I have also shown the connections which should be used under these conditions. J. H. SAUVE.

Reardon Pulp and Paper Company, Temiskaming, Que., Can.



Connections for testing outfit when used on circuits of various voltages and frequencies.

Copper Balancing Strips Cause of Armature Burnout

CIRCUMSTANCES under which the armature of a motor burned out recently were so unusual that they may be of interest to the readers of INDUSTRIAL ENGINEER.

This armature was of the closed-slot type and had no bands on it. In order to balance it, the winder had put copper strips in about five of the slots and evidently had not taken the trouble to insulate the strips from the core. After the motor had been in operation for some time the armature burned out and had to be completely rewound. On examination it was found that the fiber wedges and the insulation of the wire of the coils lying in the

slots in which the copper strips had been placed, had been thoroughly charred and burned.

The only explanation I could find was that heavy currents were induced in these strips as they passed under the pole pieces. The copper was then heated to a temperature high enough to char the wedges and eventually burn the insulation on the wire. GEORGE RINGNESS.

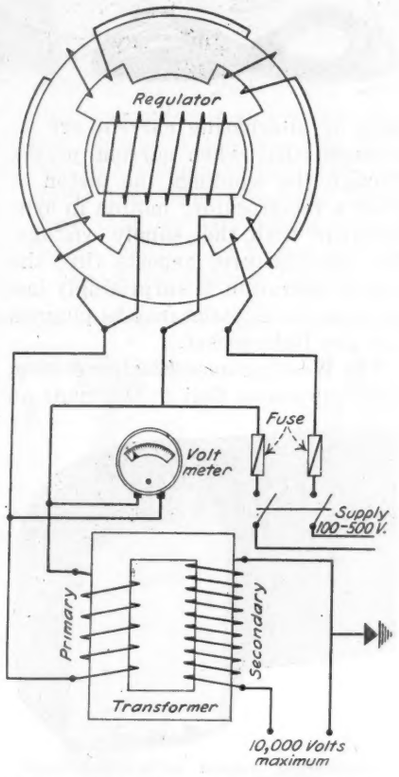
Peoria, Ill.

Methods of Making Dielectric Tests on Insulation of Electrical Equipment

ELECTRICAL equipment in industrial plants often has to undergo repairs, and it is necessary on their completion and before the apparatus is again placed in service, to test for faulty workmanship or material. Insulation repairs should be capable of withstanding a pressure test at least double the rated voltage of the apparatus on which the repairs have been made.

There are two methods of applying a high-voltage test to electrical apparatus. The full pressure may be switched on at once, or provision may be made for gradually raising the pressure from a low value up to the required voltage value for the dielectric test.

Imagine the high-tension winding of a transformer with one end attached to the terminal of a single-pole switch used for interrupting the connection to a source of high voltage. Before the switch is closed, the entire transformer coil is at earth potential. At the instant of contact between the blade and the switch jaws, the wire leading from the switch to the first turn on the transformer coil is raised immediately to the potential of the line. The remaining portion of the coil will become charged in an infinitely short time, but as the charge has to pass through a highly inductive winding it is momentarily held up while the successive layers are being raised to the potential of the line. This results in a momentary high potential between the outside layers and may reach the full voltage at the instant of closing the switch and cause across the outer layers of the coil an almost invisible discharge which punctures the insulation. The discharge contains a very small amount of energy, as only sufficient will pass to bring the remainder of the coil to the potential of the line, when all difference of potential between the layers of the appreciable difference of potential existing at any time between the layers of the coil.



Connection diagram of testing outfit for making high-voltage tests.

The diagram shows the connections for a testing apparatus designed to give a secondary pressure from zero to 10,000 volts on a primary supply voltage of 100 to 500 volts, as desired. The apparatus consists of an induction regulator of suitable capacity for the transformer with which it is to operate. The primary side of the regulator is connected to the supply, while its secondary terminals feed the leads of the primary side of the transformer, which may have taps corresponding to the maximum test pressures which the apparatus can supply with the regulating transformer set for full voltage. A voltmeter provided with a double scale is connected across the leads of the primary side of the transformer, one scale reading the low or primary voltage, while the other scale is marked to register the corresponding high-pressure potential delivered for the impressed primary voltage. The iron core upon which is wound the secondary of the regulator, is movable, and may be rotated through 45 deg. In the position of zero potential, the secondary is so placed that the ends of the core are opposite the narrow portions of the surrounding iron ring on which is wound the primary winding in series with the line. In that position no lines of force from the magnetized ring find their way into the movable core, and consequently no voltage is induced in the secondary winding. When the core is slowly rotated by means of a hand-wheel, its ends gradually assume the position shown in the figure, corresponding to maximum voltage, which results from the core being opposite two of the definite pole-pieces on the surrounding core. It will be noticed that this method gradually builds up the testing voltage from a low value to the value required for the dielectric test.

One important point in making pressure tests is that of determining the proper value of the testing voltage to apply. When making tests of alternating-current apparatus, it is important to determine whether the apparatus is intended for service with the neutral grounded or insulated.

If the neutral is grounded a dielectric test to earth equal to twice the phase voltage should be applied. This would be equal to twice the line voltage divided by the square root of 3. If the neutral is ungrounded the dielectric-test voltage should be twice the line voltage. There is no objection to applying dielectric tests to d. c. apparatus with a supply from an a. c. circuit, but precautions are necessary to prevent applying too high a voltage. In dealing with alternating current, all references to measurements of current or voltage mean their r. m. s. values. This value is equal to 0.707 of the actual maximum values reached, so that when an a. c. voltage of 1,000 volts is shown on a voltmeter, the actual stress placed upon the insulation is that produced by $1,000 \div 0.707 = 1,400$ volts, approximately. Therefore, when a direct-current machine is to be tested, due allowance must be made for the maximum values of e.m.f., when arriving at the testing pressure that is to be used. A. FOKES.

Walton-on-Thames, Surrey, England.

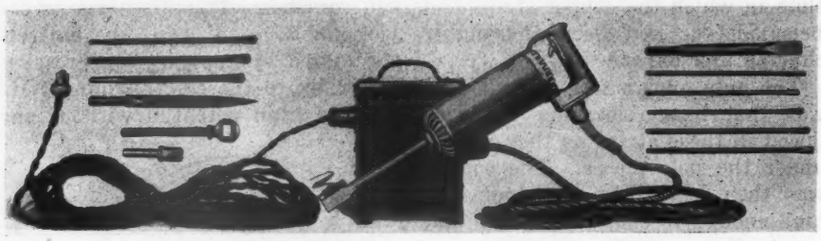
Recent Electrical Equipment

(*Continued from page 80*)

Joseph Weidenhoff, Chicago, Ill., has developed a new armature tester known as the Armature Test-o-meter. He states that the armature to be tested is placed in this device and contact fingers are applied to each successive pair of commutator bars as the armature is rotated in the gap between the pole pieces of the device. Readings are given on a meter which shows whether a coil is defective, the exact nature of the fault, and the slots in which the defective coil is wound.

Miscellaneous Tools.—The Martindale Electric Company, Cleveland, Ohio, has developed a new commutator slotter which is designated as the Imperial Undercutter. The maker reports that this undercutter is the only one that will cut a "V" shaped slot, and claims that a "V" shaped slot is best because it is self-cleaning at all times, automatically prevents undercutting too deeply, and practically avoids the possibility of leaving strips of mica along the edges of the bars flush with the commutator surface.

The National Electric Mfg. Company, Pittsburgh, Pa., has developed a new electric hammer drill which is known as the Syntron. Its mechanism consists of a hardened steel piston moving in a cylinder in which two powerful field magnets energized by alternating current are so arranged that when current passes through the windings the piston is given a reciprocatory motion in synchronism with the supply voltage. The manufacturer reports that the cost of operation is surprisingly low and that the Syntron may be plugged into any light socket.



Syntron electric hammer made by the National Electric Mfg. Company of Pittsburgh, Pa.

This hammer makes 3,600 strokes a minute and is adapted for drilling through stone, concrete, masonry and the like.

The Westinghouse Electric & Mfg. Company states that it has made an application of a rectigon controller to a reciprocating solenoid hammer for drilling or cutting stone and concrete, chipping castings or work of a similar character.

Aluminum wound series field coil made by the Economy Electric Devices Company, Chicago, Ill.

The oxidized aluminum on the surface of the wire forms the insulation between turns on this series field coil.

The General Electric Company has developed a new method of testing underground cables to determine the condition of the insulation and to locate cable faults. High-voltage direct current obtained from a kenotron is used. A kenotron is a rectifier that is an off-shoot of the radio audion or vacuum tube.

The Electric Tester Manufacturing & Sales Corporation, of Portland, Ore., has brought out a fuse tester which can be used on any voltage from 100 to 600 without any changes. The maker points out that it is safer than the old lamp and socket method of testing and that it prevents the breaking of so many test lamps, due to dropping or putting a low-voltage lamp on a high-voltage circuit.

The Black & Decker Manufacturing Company, of Baltimore, Md., announce a portable electric screw driver and socket wrench for heavy duty production work. The maker states that this tool, weighing but 15 lbs., has been designed particularly for driving very large wood screws, lag screws, and running up nuts on large bolts. The spindle is equipped with a positive clutch which automatically disengages when the forward pressure on the tool is released.

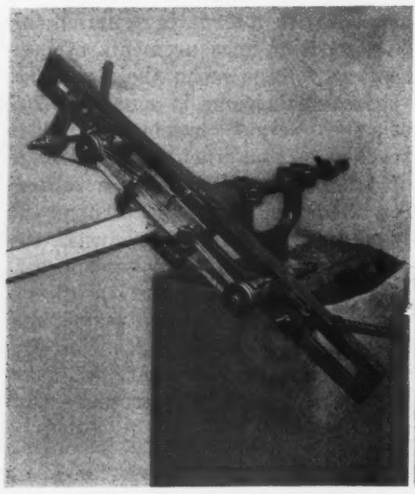
The Easy Manufacturing Company of Lincoln, Neb., has put on the market a new size of pipe pushing machine which it states will force conduit ranging from ¾ in. to 2½ in. through any ordinary soil. The maker states that with this machine it is unnecessary to dig a trench for laying conduit underground.

The Hobart Bros. Company, of Troy, Ohio, has developed a device for charging storage batteries from a constant potential circuit. The appliance consists of a carbon-pile resistance, an ammeter, a clamp for connecting to the supply bus and a connector, combined in one device.

The Economy Electric Devices Company, Chicago, Ill., is introducing to industrial plants an aluminum-wound series field coil which

Combination coil winding and spreading machine made by B. T. Coil Former & Tool Company of New York, N. Y.

After the coil is wound as shown in the left-hand picture it is spread either by hand or by turning a crank on the end of the machine.



has found a wide application in the street and interurban railway field. Aluminum has the property of oxidizing very easily and when this oxidation is produced by chemical means there is formed around the conductor a dense, hard film which the maker says obviates the necessity of insulation between turns of a series field coil. It is pointed out that these aluminum-wound field coils are designed to give the same field strength as copper coils but have the following advantages over copper coils: longer life, approximately 50 per cent weight reduction, more rapid conduction of heat from coil, less affected by moisture, less chafing, less renewals and less total cost. The Economy Electric Devices Company takes advantage of the high salvage value of a mechanically damaged aluminum field coil and makes a replacement proposition under which it states that it will furnish duplicate coils for 60 per cent of the sale price of a new coil, plus the return of the damaged coil. The maker states that this gives the user of these coils an exceptionally low ultimate cost and no higher first cost.

The Pure Carbon Company, of Wellsville, N. Y., has developed a new brush known as Grade G 48. The maker states that this is a soft graphite grade of laminated texture and is so designed as to bring the laminations across the width of the brush, resulting in a high resistance across the grain, rather than with it. The ratio of the resistance is approximately five and the manufacturer points out that this grade has decided merits from a commutation standpoint in cutting down cross bar currents. The material across the width and along the length has a resistance per

Wiring devices and tools that will save money for the operating or maintenance departments.

(A) is a reel for paying out and automatically retrieving conductors. (B) is a conduit cover which has a universal joint that holds a light fixture in a vertical position even though the conduit is tilted. Both (A) and (B) are made by Appleton Electric Company, Chicago, Ill. (C) is a lamp guard made of expanded steel and designed for the new mill type lamps. Made by Flexible Steel Lacing Company, Chicago, Ill. (D) is a plug with a grip for clamping to cable. Made by Arrow Electric Company, Hartford, Conn. (E) is a laminated brush made by the Pure Carbon Company, Wellsville, N. Y. (F) is the rotor of type TR motor made by Triumph Electric Company, Cincinnati, Ohio. (G) is a swivel hanger made by Quadrangle Manufacturing Company, Chicago, Ill. (H) is an armature testing machine made by Joseph Weidenhoff, Chicago, Ill. (I) is a strip heater made by Edwin L. Wiegand Co., Pittsburgh, Pa. (J) is a push and pull switch and enclosing box made by Arrow Electric Company. (K) is a commutator slotter made by Martindale Electric Company, Cleveland, Ohio.

cubic inch of 0.0015 ohm and the resistance across the thickness is approximately 0.008 ohm. The maker reports that this brush has a very wide range of service in the graphite series and is especially adapted for slotted commutators on large generating equipment and for this class of service the brush has shown very exceptional results on large installations during the year of 1923.

The C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., has added an electric, contact-type temperature controller to its line of instruments. By means of this instrument the temperature of any device such as a refrigerating unit may be automatically controlled.

The Autovent Fan & Blower Company, Chicago, Ill., has developed a portable window ventilator which the manufacturer reports is especially adaptable to industrial plants. The ventilator is furnished complete with an adjustable frame which is formed from sheet steel and is so designed and constructed that it is adjustable to any width window frame. This unit is also furnished with an 8-ft. extension cord and plug so that the fan can be conveniently attached to a light socket or other outlet. This company has also added to its line an acid-moisture-proof fan, which has an aluminum frame motor, totally enclosed so that there is no possibility of corrosive substances such as acid fumes, gases, or foreign particles entering the motor. The Autovent acid-moisture-proof fan is, therefore, especially adapted for battery charging stations, dye-houses, enameling and plating departments; in fact, every place where an acid solution is required for a manufacturing process.

The Albert & J. M. Anderson Mfg. Company, of Boston, Mass., has brought out a very high capacity plug and receptacle. The new device is rated at 1,500 amp. and 440 volts. Dossert & Company, New York, N. Y., report that installation costs can be reduced by the substitution of Dossert connectors for disconnecting switches on the secondaries of distributing transformers, where a disconnecting switch is installed only to give an easy means of isolating transformer secondary.

Wiring Devices

The Adapti Company, of Cleveland, Ohio, has recently put on the market an "Always Vertical" condulet cover which is designed to permit a lamp fixture or pendant to hang correctly even though the outlet box has to be installed at an angle, due to the shape of the roof or the manner in which the conduit must be installed. This cover has a universal joint which permits the pendant to adjust itself as much as 20 deg. from the normal to the condulet cover. The Appleton Electric Company, of Chicago, Ill., manufactures a combination hickey and swivel fixture joint which performs a similar function. The Quadrangle Mfg. Company, of Chicago also makes a "swivel hanger" which is designed for similar use.

The Appleton Electric Company reports that maintenance costs can be reduced by the use of its heavy-duty "Reelite," a self-contained device for paying out and automatically retrieving electric conductors for power and light. The maker states that this device is particularly adapted to cranes, magnets, electric motor buckets, and arc-welding sets

The Flexible Steel Lacing Company, Chicago, Ill., has put on the market a new lamp guard especially designed for the new 25- and 50-watt, mill-type lamps. It is made of expanded steel, reinforced and tinned.

The Arrow Electric Company, of Hartford, Conn., has developed an attachment plug with an "Arro-Grip" device. The maker states that this attachment grips the cord end securely so that when the plug is jerked out by pulling the cord, the plug and cord are protected from breaking. This device is also applied to lamp sockets. This company has developed a push and pull switch with a box which is dust-proof and waterproof and is particularly adapted for use in industrial plants where it will be subjected to a great deal of dust or vapor.

The Mica Insulator Company, of Chicago, Ill., has developed a varnished cambric tape that is bias cut and seamless. The Irvington Varnish & Insulator Company, of Irvington, N. J., also make a seamless bias-cut varnished cambric tape. Rockbestos Products Corporation of New Haven, Conn., has put on the market a new conductor which is designated as "panel wire." The manufacturer reports that the insulation on this wire includes nothing but asbestos, and is indestructible by fire, will not deteriorate in service, nor will the insulation crumble.

The Chicago Solder Company, of Chicago, Ill., reports that its Kester self-fluxing wire solder has recently been approved by the Underwriters' Laboratories, stating that the fluxes used are not likely to cause corrosion to the soldered parts and that the fluxes form a secure mechanical and electrical bond between the solder and metal to which they are applied. The Kester solder incorporates the use of three types of flux which is enclosed in the hollow structure of the solder.

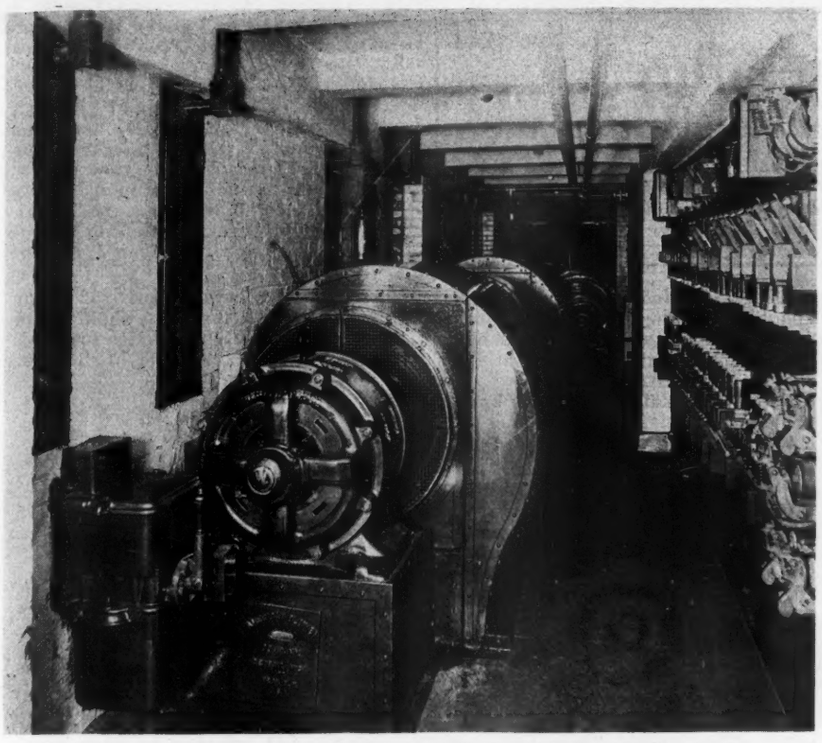
Use of Individual and Group Drives

(Continued from page 60)

individual drives will, therefore, show higher losses than alternating-current or direct-current group drives. Furthermore, where alternating-current power is generated or purchased, the light load losses of converting equipment operated overtime, nights and Sundays to serve a few overtime workers or mechanics doing repair work will more than offset the lineshaft friction losses due to an equivalent amount of overtime work in a group-drive plant. Also, if the proportion of variable-speed motors required is not large, the elimination of such conversion losses will go far toward offsetting the losses from slip-ring alternating current motors on those few drives.

2. Maintenance of Shafting and Belting Eliminated.—Where individually-driven machines can be directly coupled to their motors without compensating disadvantages, the elimination of power-transmitting intermediaries is a very real advantage. In this class of drives come most centrifugal pumps, some fans such as cupola blowers and high-speed centrifugal compressors for forge fires, oil furnaces and the like. It is very general practice to direct-connect fans wherever possible but in the light of fifteen years' experience, the writer favors belt drive for reasons which will be given later.

3. Cleaner Shop.—In certain industries such as the textile industry, any gain in making the shop cleaner is worth considering and it



Some machines run at so high a speed that operation from a group lineshaft is inconvenient or impossible.

In such a case, if they offer a fairly heavy load approaching their maximum load, they can be individually driven to advantage.

may even be a controlling cause of choice.

4. Better Light with Individual Drive.—Better lighting obtained with individual drive is a point emphasized in most of the published discussions on this subject. It is true that in the old type of manufacturing building with low ceilings and inadequate window area and an engine drive involving much heavy shafting and large belts, this point is well taken. With manufacturing buildings as they are constructed nowadays, "walls all windows" and high ceilings, the shafting necessary for an intelligently planned group drive involving 10 hp. to 50 hp. groups cannot be said to seriously interfere with either the natural lighting or whatever artificial illumination is used.

5. Closer Speed Adjustment of Tool to Work.—Previous to the advent of high-speed steel and scientific management, the great majority of machine tools were limited to three or four speeds, generally obtained by means of cone pulleys. When a closer study of speeds and feeds led to a demand for finer speed adjustment, the first solution generally offered was individual, direct-current electric drive with multiple voltage and field control. This was effective but very expensive, as are all variable-speed motor drives having a considerable speed range and requiring full torque at low speed. The cost and complication of this system led to the development of various other methods of reaching the same result. Some of these schemes involved the use of direct-current motors with gears for the major changes and field control for variation between the speeds given by the gears; single-voltage, direct-current motors with compensating windings, practical for speed ranges as great as six to one; the two-speed and four-speed alternating-current, squirrel-cage motors, the latter with two windings and consequent pole connections for half speed on each; and so on.

At the present time machine tools for group drive are obtainable with as many as eight speeds by quick gear shift, and the possibility of sixteen speeds by the use of an ordinary two-speed countershaft. It is doubtful, whether any ordinary lathe, for example, gains appreciably in output by finer speed adjustment than this affords. There are cases where a wide range of speed control is necessary on a considerable number of machines, including machines with heavy individual power demand. Such a condition generally justifies the direct-current individual drive.

B. LOCATION OF MACHINES TO SUIT CONTINUITY OF MANUFACTURING PROCESSES WITHOUT REGARD TO THE LOCATION OF LINESHAFTING.—If the arrangement of lineshafting is intelligently planned, location of group-driven machines in proper sequence and position for economical manufacturing seldom offers any particular difficulty. In those instances where this is not true by all means use individual drive for the machines affected. In my experience the instances of this sort comprise less than 5 per cent of the total number of machines. Most of such cases are machines which are best located in rooms or parts of rooms with no other power-driven machinery nearby.

C. WHEN ONLY A SMALL PROPORTION OF THE INSTALLED MACHINES ARE TO BE OPERATED, AS FOR OVERTIME OR SLACK SEASON, IT IS NOT NECESSARY TO OPERATE IDLE SHAFTING AND BELTING.—In the rare cases of a single machine in a room frequently operated overtime or all night it is often best to drive that machine individually. When several related machines carrying on the successive steps of a process are operated during slack seasons, with several other groups shut down, it is frequently possible to group these machines on one motor. Where the reduced operation will continue for a considerable time, as during a dull season, it is possible to remove the belts from the group-driven lineshafts to the countershafts and thus avoid the greater part of the power loss. In general, the power loss is small, and amounts to far less in a dull season than the fixed charges on the extra investment which would have been required to install individual drive.

D. ON LARGE WORK THE TOOL MAY BE TAKEN TO THE WORK, INSTEAD OF THE WORK TO THE TOOL.—On very heavy work, such as large engine bedplates, slow-speed alternator field frames and the like, it is often more convenient to move the machine tools to the work than it is to move the work. It is self-evident that such portable machines are best suited to individual drive, and this should be employed.

In the foregoing the writer has attempted to show that the reputed advantages of individual drive are not so great as commonly supposed. In another article the advantages of group drives as outlined in the tabulation on page 57 will be taken up and discussed in detail.

Trade Literature
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of the bulletin or catalog desired, as given in these columns.

Dossert and Company, 242 West Forty-first Street, New York City.—The sixty-four page twentieth annual catalog of Dossert solderless connectors for stranded and solid wire, rod and tubing, is not only larger but also contains considerable data and information not included in previous catalogs. One of the features is an explanation of the method of putting together a typical Dossert joint. This is well shown by illustrations. In addition, twelve of the most frequently encountered types of joints and how they can be made into Dossert joints are illustrated.

Bond Foundry and Machine Company, Manheim, Lancaster County, Pa.—Catalog K-5 describes and lists the various anti-friction industrial truck casters with ball-bearing swivel and roller bearing wheels. Stationary, rubber-tired and special casters are included.

Bailey Meter Company, East Forty-sixth and Euclid, Cleveland, Ohio—Bulletin 200 describes the "Bailey" tachometer which is used to indicate and record speeds of turbines, stokers, paper machines, fans, centrifugal pumps, and other similar equipment.

Glow-Brite Company, 1006 Rockefeller Building, Cleveland, Ohio.—A new folder, "Let in Daylight, Use Glow-Brite," describes the use of this liquid glass cleaner for cleaning windows and skylights in factories, foundries, steel mills, and the like.

Reliance Electric and Engineering Company, Ivanhoe Road, Cleveland, O.—A 32-page booklet entitled "Electric Motors—How to Choose and Use Them" gives some interesting, practical information on this subject. Among the seventeen topics discussed are: Load factor and motor cost; individual or group drive; getting the right kind of motor; protecting the motor; installing the motor; a method of determining size of motor required; what to tell manufacturer when asking for quotations on motors, and numerous other problems.

The Martindale Electric Company, 11709 Detroit Avenue, Cleveland, Ohio—A folder describes the "Imperial" commutator stone, shows a number of new style handles, additional standard sizes, and lists ten points or advantages, as well as giving a price list. A description of the "Imperial" commutator grinding tool is also included.

Mica Insulator Company, 63 Church Street, New York City—A 4-page illustrated letter in colors describes the application and uses of seamless "Empire" bias-cut tape with savings and points of superiority claimed for it. It also includes data regarding sizes, colors, price and quantity discounts.

E. C. Atkins and Company, Indianapolis, Ind.—The new general catalog number 19 contains 268 pages of illustrations and descriptive matter of the Atkins silver steel saws, saw tools, saw specialties, machine knives, grinding wheels, metal cutting machines, and other tools and equipment manufactured by Atkins.

American Fixture Company, 230-232 West Water Street, Milwaukee, Wis.—Catalog No. 4 describes the various types of "American" Adjustable Electric Light Fixtures, shows how they can be made up of the various parts, and illustrates a number of applications as well as giving prices.

Condit Electrical Manufacturing Company, Boston, 27, Mass.—Industrial Handbook 5002 covers the line of air circuit breakers, oil switches and circuit breakers, oil motor starters, and service switches, and includes handy tables as well as the Underwriters' motor rules.

Union Electric Manufacturing Company, Milwaukee, Wis.—New bulletin sheets are issued to catalog holders which announce and price the new type XA, YA and XB drum controllers and starters.

Sangamo Electric Company, Springfield, Ill.—A folder entitled, "A Study of Meter Lubrication," contains a reprint of an article on that subject by F. C. Holtz, chief engineer of the Sangamo Electric Company.

The Johns-Pratt Company, Hartford, Conn.—A folder describes and gives the list prices of the various sizes of "Vulcabeston" pump valves, which it is claimed can be used under heat, oil, grease, alcohol, chemicals, acids, and other liquids where ordinary rubber valves will not stand up.

Automatic and Electric Services, Ltd., 173-175 Farringdon Road, London, 1.—Leaflets describe the "Wild-Garfield Electric Furnaces" for hardening high-speed steel and also an electric furnace of the radiant heat type for tempering, carburizing, vitreous enameling, japanning and annealing purposes. This furnace is suitable for temperatures up to 1,000 deg. C.

Allan Manufacturing and Welding Company, Inc., Buffalo, N. Y.—A leaflet describes the "Cyl-grind" which is a portable, adjustable grinder for the removal of excessive metal or high spots on cylindrical surfaces. Its special feature is to grind down the inside of cylinders after defective spots have been welded by electric arc or other process. The "Cyl-grind" may be adjusted or set for the desired radius while the wheel is in motion so as to remove the exact amount of excess metal. This grinder is made in two sizes; one adaptable to automotive cylinders and the other for air, steam and water cylinders of larger diameter.

Shepard Electric Crane and Hoist Company, Montour Falls, N. Y.—"A Book of Illustrated Economies" contains 68 pages filled with illustrations of applications of the Shepard Electric "LiftAbout." This is a ½- and 1-ton electric hoist. One of the interesting features of this book is that the installations are from many industries and are accompanied by a short testimonial from the user telling of the advantages and economies of the "LiftAbout."

Buffalo Fuse Corporation, 752 Main Street, Buffalo, N. Y.—A small folder lists the sizes and prices of both cartridge and plug types of "Pierce" renewable fuses.

Four Plants of the Pacific Mills

(*Continued from page 55*)

of textiles is The Pacific Mills, Lawrence, Mass., which produces printed, dyed and bleached cotton goods, cotton warp, and all-wool dress goods. This Company was incorporated in 1850 and for fifty-nine years its mills were located wholly at Lawrence, Mass. Additional mills are now operated at Dover, N. H., and Columbia, S. C. The area of all factories aggregates 182 acres of floor space.

With 11,000 employes on the payroll, which exceeds $10,000,000 annually, the Company operates 663,232 cotton and worsted spindles and 15,951 looms besides performing the many other operations required in the manufacture of cloth. If the Company's looms were placed end to end they would form a continuous line over 24 miles long. In these great mills the normal product of over 195,000 acres of cotton (about 70,000 bales) and the wool produced by 2,366,000 sheep are woven into cloth each year. About a mile and a quarter of cloth is produced a minute during the running hours. In 1921 the total output reached a value of over $72,000,000.

A better idea of the extent of the industrial magnitude of this industry may be obtained from the following figures on power service equipment in the various mills of this one Company: Over *118 miles of belting* are driven from *21½ miles of shafting.* In addition, *72¼ miles of power feeders and cables* supply power to the *2,482 motors* having a *total rating of 34,585 hp.* The motors range in size from 1/15 to 200 hp. These figures give some conception of the amount of power transmission equipment which must be maintained in proper operating condition for continuous production.